SURVIVAL
& REPRODUCTION

H. REINHEIMER

22102022725

Review. Veg. Mess. $\overline{\text{VIII}}$. 355.

Med
K3859

Digitized by the Internet Archive
in 2016

https://archive.org/details/b28078287

Cloth, 8vo. *Pp. xxii + 284.*
Price 6s. net.

Nutrition and Evolution

By
Hermann Reinheimer

"A severe and closely reasoned treatise based on a wide and close observation of biological facts, seeks to elucidate upon an evolutionary basis the fundamental laws governing nutrition. Will more than repay the attentive perusal of serious students of science."—*The Scotsman.*

"A scholarly and severely logical treatise."—*Sunday Times.*

"Deserves careful perusal."—*Glasgow Herald.*

"Clearly shows the great bearing which food problems have on life generally."—*Herald of Health.*

"A volume of real, deep interest . . . must be recognised as worthy to rank in first-rate criticism."—*Daily Chronicle.*

"Contains many good ideas. Its tendency is in harmony with the most recent views of biological research."—Dr BRUNO OETTEKING in the *Frankfurter Zeitung.*

"The author's propositions are certainly interesting and worth further testing by scientific research."—Dr W. BREITENBACH in the *Neue Weltanschauung.*

Survival and Reproduction

A New Biological Outlook

Survival and Reproduction

A New Biological Outlook

By

Hermann Reinheimer

Author of "Nutrition and Evolution"

LONDON
JOHN M. WATKINS
21 CECIL COURT, CHARING CROSS ROAD, W.C.
1910

0081

13725 900

WELLCOME INSTITUTE
LIBRARY
Coll welMOmec
Call
No. QH

PREFACE

In prefacing this, my second volume, I wish to state that there still remains a vast number of factors which furnish ampler justification for my views than I am able to demonstrate within the scope of the present essay. The subject-matter relating to the cumulative effects, both quantitative and qualitative, of nutrition, which must again be given a prominent position, is by itself of such magnitude that a further series of volumes would be imperative to bring its importance effectively home to the reader.

The minute study of cell development—invaluable as it is—has taken several generations to reach its present level, but the more important study of nutritional habits as they predetermine such developments and affect reproduction and survival has been almost entirely neglected.

Such neglect was bound to lead to confusion, and has given rise to the prejudice with which I have now to contend, quite as much as with the difficulty of establishing positive principles with regard to normality in nutrition and morphology.

It is therefore necessary to undertake the preliminary disentanglement of a geometrical progression of confusion. This is a formidable matter, intimately associated with the problem of physical regeneration, towards the solution of which I am thus endeavouring to contribute. Workers in this field will appreciate the difficulty of fighting what might be called physiological confusion of every sort. According to my view, pathological encumbrance is mainly reducible to a "parasitic diathesis," the intensification of which leads to a real geometrical progression of evil, compared with which the geometrical ratio which Malthus conjectured as a possibility in human population pales into insignificance. Malthusian empiricism can indeed no longer be countenanced, any more than the loose talk of "Nature red in tooth and claw." In the place of such, and other facile but uncalled-for generalisations, which form the unscientific legacy of Darwin's otherwise invaluable work, I have instituted a scientific inquiry into the effects of surfeit and "infeeding": (*a*) as they directly affect the organism individually, (*b*) the species, (*c*) the total biological community, and (*d*) as they indirectly produce reactions in the wider field of cosmic relation.

Just as I have for convenience epitomised my results in teleological terms, there naturally remains ample scope for contributions from many quarters towards an extension of a legitimate teleological outlook concerning the main factors in the evolution of life and form. I sincerely hope that my work may thus prove useful and stimulating in more than one direction. I also wish here to express my cordial thanks to my friends, A. H. Singleton and J. R. Potter, M.A., for their kind assistance in reading over the manuscript and for their help in various other ways.

CONTENTS

PART I.—SURVIVAL

PAGE

INTRODUCTION 3

CHAPTER I

THE PASSING OF "NATURAL SELECTION" 26

CHAPTER II

POULTON, DE VRIES, AND DARWIN 67

CHAPTER III

DARWIN (*continued*) 87

CHAPTER IV

KROPOTKIN 97

CHAPTER V

MALTHUS 134

PART II.—REPRODUCTION

CHAPTER I

NUTRITION AND REPRODUCTION 151

CHAPTER II

HERMAPHRODITISM 180

CHAPTER III

PAGE
EFFECTS OF OVER-NUTRITION ON SEXUAL ELEMENTS . . 198

CHAPTER IV

MORE ANALYSIS OF SEX 232

CHAPTER V

PARTHENOGENESIS 243

CHAPTER VI

ASEXUAL REPRODUCTION AND ALTERNATION OF GENERATIONS 281

CHAPTER VII

GROWTH AND DEATH 316

CHAPTER VIII

SPECIAL PHYSIOLOGY OF SEX AND REPRODUCTION . . 331

CHAPTER IX

INSTANCE OF THE EVOLUTION OF A CRIMINAL HABIT IN ANIMALS 371

CHAPTER X

LAWS OF MULTIPLICATION 385

INDEX 406

PART I

Survival

"A la rigueur, rien n'empêcherait d'imaginer un individu unique en lequel, par suite de transformations réparties sur des milliers de siècles, se serait effectuée l'évolution de la vie."—Professor HENRI BERGSON (*L'Evolution Créatrice*).

INTRODUCTION

"La philosophie évolutioniste étend sans hésitation aux choses de la vie les procédés d'explication qui ont réussi pour la matière brute."—HENRI BERGSON.

IN a previous volume[1] I have dealt with the evolutionary significance of nutrition, and I have shown it to be of far greater importance than has hitherto been conceived in biological work. I have demonstrated that stability and permanence of individual and racial existence depend primarily on the state of the nutritional life and on the observance of proper metabolic ratios; finally reaching the conclusion that parasitism, in the widest sense of the term, is responsible for the majority of improper ratios which result in disease, in antithetic morphological and racial developments, and in degeneration generally.

My conclusion was formulated thus: "Nature abhors parasitism." This, according to my interpretation of the facts, is but another way of stating the famous Darwinian dictum that "Nature abhors perpetual self-fertilisation." The latter formula I have found useful, as it is capable of profounder exposition and as it indicates the limit of teleological argument that I wish to adopt.

---

[1] *Nutrition and Evolution.*

In thus stating that parasitism is a main dysteleological factor, I am only indicating more concisely my view that it is the universal cause of disease, provided that all the factors relating to health and disease are seen in their due setting of cosmic interaction and cosmic correlation. In using the term "teleological" I do not wish, for the present at any rate, to indicate anything more remotely purposive than this cosmic end.

The divergence of interpretation evinced by the above two dicta concerning Nature's aversion to certain states, shows that my conception of survival is founded on a more definite rationale than that presented by Darwinism. This divergence is fully justified in that my inquiry has taken a different course from that hitherto employed, and has naturally yielded vastly different results.

Historically speaking, it may be said that it was the merit of Malthus—although even he acknowledges in his later work that much more had been done than he was aware of, when he published his *Essay on the Principle of Population*—to have instituted a serious inquiry into the relation between sustenance and population. Although utterly devoid of a biological basis, his speculations and dogmas, *mirabile dictu*, are to this day held by eminent scientific men to contain incontrovertible proofs concerning biological ratios. It is part of the irony of fate that the great Darwin, to whom credit is due for starting the inquiry as to the origin of species and the factors of evolution, totally succumbed to the fascination of Malthus' superficial generalisations, and accepted as dogma, premises which his own life-work would certainly have demolished, had it been adequately extended. I am referring, of course, to his theory of "Natural Selection"—his "principle of preservation" or the "survival of the fittest," as it has also been called. This has been claimed by some as the sole means by which the origin of new forms takes place, whilst others at least concede that "the evidences of evolution are much more numerous and more weighty than the evidences of the survival of the fittest," and others again urge that Darwin's method does not explain how there could arise a number of different structures or parts so co-ordinated as to share in a common function.

It was Herbert Spencer who expanded the inquiry by examining into the question: Who are the fittest? and credit is due to P. Kropotkin and Henry Drummond for emphasising the importance of mutual aid, of co-operation, altruism, and of sacrifice as factors in evolution quite as powerful as the "struggle for existence." More recent criticism has gone so far as to ask: "How much fitness is sufficient to lead to survival?"

No satisfactory answer to these queries is forthcoming, thanks to the tangle in which the unfortunate infusion of Malthusian empiricism and prejudice into Darwinism has landed us. The bias in favour of "Natural Selection" is now as strong as was in pre-

Darwinian days the prejudice in favour of the doctrine of special creation. A Herculean effort, involving at least a wholesale reconstruction of biology, is needed to uproot this prejudice.

It is necessary to go back to the premises from which Malthus and Darwin started in forming their generalisations, and to examine them carefully in the light of more recent developments. It is necessary to examine the physiological basis of life—the incidences of nutrition as they affect growth and reproduction, both in a physiological and a pathological sense.

In *Nutrition and Evolution* I have provided a first instalment of a study of the cumulative (physiological, morphological, and pathological) effects of nutrition, and its teleological significance in general. It has there, I think, been shown—although perhaps somewhat too fragmentarily—that "selective" philosophy is being put out of court. In the present volume my purpose is to continue the criticism of what I believe to be the impeding "principle" of selection, and to establish the teleological rationale of preservation and survival as adumbrated in the first volume.

As regards the use I have made of teleology, once more I strongly insist that it is not my wish nor task to interpret the world as a whole as a purposive system. All I wish to imply is that the term "useful" as employed by Darwin and his followers is insufficient, and that a cosmic concept of "usefulness"—based on the widest possible considerations of stability, health, interdependence of life and correlation of growth—must be framed.

This closer definition of "usefulness" will also be found to provide the clue to the problems of reproduction. If, for convenience' sake, I have spoken of a teleological rationale, it must be clearly understood that whatever teleology is involved, is justified by facts of observation, and is not a matter of mere cloudy conjecture or empirical and metaphorical nonsense. These wider standards of usefulness which I am endeavouring to introduce, and which are so sadly lacking in Darwinism, have their foundation in the universality of facts observable throughout nature, and they will be found to apply as well to ethics and æsthetics as to biology; that is to say, whatever is physiologically healthful will be found to be both ethically and æsthetically desirable. They thus provide, as it were, macrocosmic tests by which to determine the legitimacy of microcosmic development.

Anyone honestly wishing to challenge my views is, of course, very welcome to do so. But, if criticism is to be effective, it must state categorically in what particulars I am wrongly interpreting observed facts, and must also show that my physiological position is unsound. So long as no serious challenge is forthcoming, I shall adhere to my indictment of modern biology as providing interpretations of facts which are in the main inaccurate.

The following summary of the points and propositions contained in *Nutrition and Evolution* may serve in the place of further introduction to the present volume :—

1. The principle of Evolution applies to inorganic bodies as well as to organic.

2. The slow and gradual character of the changes taking place in a system (inorganic or organic) is of the utmost importance. Such changes may provide the incipient stages of "variations."

3. The success of impacts from without in producing pronounced "variations" depends as much on the constitution and stability of the system as on the power and recurrence of the impacts.

4. The appearance of "sports" ("spontaneous" or "capricious" variations) is frequently a matter of dissociation (disintegration of the intra-atomic or intracellular energy).

5. Laws of constant proportions and of crystallisation are universal ("symmetry is a character whose presence among organisms approaches to universality"), and hence architectural aspects are diagnostically significant. A mineral being is characterised by its crystalline form in the same way as the living is characterised by its anatomical form, and it passes through a progressive evolution before reaching its definite shape. The individuality of the crystal individualises molecules of matter in the same sense that the living being does, by incorporating the elements seized from the environment. All solids tend towards the crystalline form. Structure in general is of the utmost importance.

6. The presence of impurities weakens resistance and is responsible for instability and subsequent disintegration in atom, mineral, vegetable, and animal.

7. Pure bodies alone are stable.

8. Radio-activity and phosphorescence are indications of dissociation (pathological "variations").

9. Dissociation implies change of equilibrium, isomerisation or rearrangement of parts.

10. The word species implies definite inherent strength as outwardly expressed in definite generic structure—pathological constituents, if present, being reflected in outer features.

11. Disaggregating phenomena are widely prevalent, rendering the rarer cases of normality frequently inconspicuous.

12. Every organism inherits a patrimony of equilibrium representing the community of descent.

13. True breeding conduces to symmetrical structure.

14. Beauty and utility in their true (teleological) significance are identical.

15. The more we are made to conceive of matter as but a form of energy, the more importance must be attached to function.

16. Every equilibrium is involved in constant interactions with others; its energies form part of a cosmic scheme of division of labour. Every equilibrium thus occupies a teleological position. The laws of constant and definite proportions are but expressions of cosmic obligations, as they are incumbent upon every equilibrium forming part of the cosmic scheme.

17. The purpose (or at any rate the result) of the integration of matter is the achievement of stable equilibria—surviving the causes which generated them. (This introduces the biological concepts of "memory," "history," and polarity. According to De Vries, protoplasm is not a chemical but a morphological conception. It is possessed of certain "historical" properties besides its physical and chemical ones. Weismann (*Germ-Plasm*, p. 39) states: "Most, in fact probably all, kinds of protoplasm with which we are acquainted possess historical qualities, not *in addition to*, but *within* their physico-chemical ones; that is, they contain special modifications of construction peculiar to themselves which arose in adaptation to the conditions of life, and have been transmitted for a long period of time.")

18. Even in dissociation certain definite requirements of law and order obtain.

19. Every equilibrium has an appropriate reagent capable of dissociating it.

20. "Environment" may be defined as the aggregate of forces capable of entering into dynamic relation with an organism.

21. Seeing that the contact of heterogeneous bodies is enough to produce dissociation, it is clear that principles of degeneration are frequently involved in various phases of association and union.

22. Inorganic dissociation has its analogue in the diseases and retrograde transformations of organisms which show aberrant modes of life.

23. Impregnation of animal tissue with inorganic matter produces dissociative effects.

24. The existence round most chemical elements of a whole series of varieties with common characteristics capable of being brought back to a common state (a kind of "reversion"), though with properties sufficiently *sui generis* for them to be distinguished, presents the precise analogue to the phenomena of variations among "organised" beings. (According to Weismann's theory "variations spontaneously arise according to the relative vigour or dynamic status of the particles of the germ-plasm.")

25. It is normal for organisms to fluctuate to and fro, to oscillate around an average type (*minus* and *plus* variations)—powerful racial and teleological influences meanwhile continuing to hold a species true to type. (Archdall Reid states that a progressive variation results "from the complete recapitulation of the parental development *plus* an addition.)

26. Innate faculties, like organs of a body, are the result of ages of effort, sacrifice, and elaboration; hence it is that phenomena of retrograde metamorphosis are the less pronounced the higher the stage of elaboration, *i.e.* the higher we ascend in the scale of life.

27. Every increase of inner strength renders an organism capable of entering into relation with a wider environment. A direct proportion exists between inner strength and environment.

28. The dynamic and teleological status of an organism (depending primarily on its powers of auto-

nomy) may approximately be gauged from a computation of the environmental work done by the species wherever a projection of its specific powers can be studied. Such computation—as Darwin's genius exemplified for us in his study of the earth-worm (where the teleological aspect, moreover, is clearly seen as primarily depending on the state of nutritional habits)—emphasises a macrocosmic view of life, and in this direction ample scope still remains for a legitimate extension of Darwin's far too cursory study of "usefulness."

29. Autonomy is most open to lapse on the side of nutrition—most markedly so in low stages. In extreme cases appropriation may be so exaggerated as to become the all-absorbing function of life.

30. Nutritional degeneration results in dissociation, in decline from teleological position—change of vocation and of opportunities.

31. POLARITY may be defined as the generic momentum determined by the sum total of inherent capacities on the one hand, and by the forces of definite cosmic laws of combination and association on the other hand—these latter forces being expressive, as it were, of the wider social obligations incumbent upon every organism by virtue of its participation in the cosmic scheme.

32. PREPOTENCY is a quality depending on the soundness of intra-organismal arrangements. Where the resultant of a system points in the positive direction, there is scope for enhanced prepotent

influences; wherever instability prevails, there is liability to the influence of undesirable emanations—the system has suffered itself to become susceptible to disease.

33. SUSCEPTIBILITY is founded on instability, and marks the beginning of disease—nutrition forming the universal medium by means of which powerful extrinsic potencies are perpetually introduced.

34. Prepotency plays an eliminative, regulative rôle, and the function of ELIMINATION in this connection is seen to be approximately identical with that assigned by Darwin to "Natural Selection."

35. DISEASE may be defined as deficiency of stability resulting in susceptibility to negative prepotencies.

36. The growth of disease is marked by an invasion of waste matter, forming the soil for microbes, by plethora, structural abnormalities, various antitheses, and loss of generic architecture.

37. Such developments are mainly fostered by, and inseparable from, Parasitism.

38. IMMUNITY is the opposite of susceptibility.

39. Parasitism starts with a lapse in autonomy resulting in physiological aberration and a loss of polarity. It disturbs the balance of nature and brings the transgressor into conflict with her powerful teleological forces. Retribution inevitably follows.

40. The term Parasitism is here used to connote every condition whereby one organism lives in any way predaceously, stealthily, or indolently, *i.e.* retrogressively, by the work of others. In view of the dynamic

interdependence of life, the epithet must also apply to all transitory phases of violation of fundamental laws of assimilation and division of labour, even the highest and most strenuous organisms occasionally being guilty of such transgressions.

41. Parasitism in course of time constitutes a degeneration *sui generis*, so much so that eventually the last vestige of higher descent may become effaced.

42. Liability to afflictions attending upon parasitism is founded on previous parasitic propensities; hence parasitism is a pathological state. It teaches the lesson how not to "survive."

43. In the history of organisms, necessities may arise which entail nutritional changes; but some way of escape from adaptation to a parasitic mode of life is always open.

44. The charge of parasitism in less obvious cases is shown to be justified by the following symptoms:—lapse of erstwhile physiological conditions into pathological ones, accented phenomena of dissociation, disorganisation of heredity and of organic structure.

45. If it be said of rank parasites that "the complicated development through which these forms thus pass, and the many chances of destruction which await the countless ova discharged from the affected animals, constitute providential means whereby the development of these forms to an annoying extent is checked and prevented, otherwise such animal-pests would soon threaten to exterminate their hosts," it can with greater scientific precision be maintained that the status of such

a species has become so dysteleological that a number of definite factors combine towards its extermination.

46. The predatory habit constitutes a first phase of parasitism, from which recoveries, however, are possible.

47. Sluggishness of life and its precarious results are the concomitant of impure and indirect feeding. Invertebrate animals are endowed with a much slower blood-circulation (consequent upon their less perfected nutritional state) than the Vertebrates. They are thus physiologically backward; but this difference of velocity is physiological, and must not be confounded with those accelerated developments symptomatic of the parasitic life which are calamitous and due to dissociation.

48. Although in forty-two days *Paramœcium* may be made to produce 1,384,116 young—that is to say, a single individual organism measuring 0·2 mm. long grows 277 metres in bulk—this is but comparable to a single higher organism drifting into obesity (which now happily we begin to recognise as a pathological state). Such dysteleological development and resulting "unfitness" must sooner or later involve an organism in "struggles" and curtailments (purporting teleological accommodation). An overgrown *Paramœcium* may be said to be in a state of teleological top-heaviness—implying fatalities which a mere breeding experiment, omitting the interdependence of organisms, will never disclose.

49. Parasitism means a neglect of function, with a

gradual loss of faculty, and hence develops the tendency for the young to become ever more retrogressively varied from the original parental type, which itself becomes "rudimentary."

50. The study of the physiological interdependence of organisms emphasises the teleological significance of nutrition.

51. The wide biological distribution of various well-recognised diseases points to the fact that all pathology is reducible to a universal cause.

52. Carnivorous and omnivorous animals—similar in this respect to the lowly Onchidia and some of the Echinoderms, swallowing nothing but sand, though only digesting the nutritive organic particles mixed with the sand—present examples of indirect or circuitous feeding with pathological results.

53. The wide occurrence of deficiency of lime salts, with consequent malformations, shows that in the matter of assimilation an organism cannot at the same time gratify perverted instincts and serve the purposes of physiology and of cosmic order.

54. The partaking of inappropriate food is prejudicial to the selection and assimilation of appropriate food.

55. By a continual substitution of inappropriate food for natural food, higher forms have provided the soil for non-pathogenic bacteria to evolve slowly into pathogenic forms. From the same cause, and *pari passu* with the development of pathogenic bacteria, many animal types have become extinct, which shows that

all adaptation is correlated adaptation, and must depend for its legitimacy on a teleological rationale.

56. The road to extinction is marked by disease and a loss of organic beauty (deterioration of teleological status), such as that sustained by plants in saprophytism and parasitism.

57. The loss of chlorophyll is fatal both from the generic and cosmic point of view (loss of teleological status).

58. Parasitism is responsible for suppression of adult stages and for pædogenetic developments (curtailment and limitation of life), as well as for metamorphoses.

59. The statement that "la larve n'est qu'un embryo à vie indépendante" needs supplementing by the explanation that such precocious developments are determined by a parasitic diathesis, which precipitates disaggregation and thus results in reproductive nemesis. The persistence of such pædogenesis ("independence"!) is of course prohibitive of the important social (and teleological) factor of parental care for the young.

60. Loss of structure, erroneously regarded as "economy" in the parasite, is not *secundum naturam.*

61. Reproductive functions are intimately associated with nutritive functions, and become increasingly specialised with the advance of sentience.

62. The qualification of a mammal implies all-round regularisation (symmetry and non-acceleration) of growth, a steady use of faculties, an advance of co-operation, of altruism, and of æsthetics.

63. Parasitism may be viewed as a factor antithetic to progressive evolution.

64. Sexual dimorphism, as manifested in antithesis of size, marks pathology and distortion of polarity (loss of teleological status). It is a step towards the dissolution of equilibrium—a retrograde transformation in the direction of the lowest forms of life characterised by amorphism.

65. So highly pathological a phenomenon as the persistence for a long period of pigmy males strikingly shows the inadequacy of Darwin's "Natural Selection" theory. The metamorphoses of insects present similar difficulties on this theory. The contrasts between mature and larval forms are symptomatic of an antithetic break-up of polarity, and require no "selective" explanation.

66. Darwin used the phrase "struggle for existence" in a wide and metaphorical sense. If at the back of his mind he had the idea of necessity as a main driving force in evolution, he was not far wrong; it needs, however, a proper study of physiological laws to arrive at a true appreciation of the various necessities obtaining.

67. False conceptions of "selection" have hitherto obstructed the recognition of the pathology of parasitism.

68. The proposition that parasitism among certain Crustaceans is confined to the females, is erroneous and based on an inadequate biological analysis.

69. Normally, male and female should not greatly

differ in strength nor in general feature. If differentiation is an excellent mode of progress, on the other hand the very fact of progress implies greater similarity in all essentials, for it means greater stability.

70. If in the higher animals there is little contrast between the sexes, it is because such a state is the indispensable condition of the higher life.

71. Metamorphosis persists through most animal series, though in many cases they are passed through within the egg. The condition in which different embryos quit the egg thus varies with different organisms. The higher the teleological status of a species, the greater is the beneficence of reproduction in respect of care of offspring.

72. Antithesis of size among snakes, fishes, and invertebrates is symptomatic of the wide predominance and dire effects of parasitism. Antithesis is closely associated with retribution, frequently in the shape of cannibalism. There may be pigmy males or useless males antecedent to a state of parthenogenesis (degenerate reproduction).

73. The mineral, vegetable, and animal kingdoms represent but different degrees of sentience and of equilibrium.

74. The plant, relative to the animal, is essentially anabolic ; this is the basis of their reciprocal relations. A true metabolic ratio exists between animal and plant, compared with which the metabolic distinction between animal male and female is insignificant.

75. The plant stores up potential forces, part of which are used up by the animal. The vegetable kingdom is nature's laboratory, where plants compel carbonic acid to yield up its carbon, water its hydrogen, and nitrate of ammonia its nitrogen. In the sacred precincts of this laboratory "not-living" matter is coerced into more elevated and complex modes of being (this providing the point of view of the teleological status of the plant). Vegetables are true reducing apparatuses ; animals are true apparatuses of combustion. Plants, in fashioning their own structures, are continually giving birth to organic substances, which are to constitute the materials necessary for the maintenance of animal life (correlated—teleological—growth).

76. To the animal, plant-food alone supplies appropriation concordant with the requirements of stability —teleological nutrition. Only when the nutritional duties of life are satisfactorily fulfilled, can the development of sex assume right proportions.

77. Plant-organised food is less charged with katabolic emanations than animal food, and hence stimulates in a physiological rather than a dissociative direction.

78. Nutritive attraction, like sexual attraction, has a cosmic significance. The aspect of inner physiological indolence in parasitism deserves greater attention than the outer "ease of attainment" aspect. Metabolic indolence spells imperfect assimilation, causing dissociative excitants to become prepotent. It is

thus that destruction is invited, the "Law of Battle" becoming the law of life.

79. Parasitism causes deterioration of physiological developments and renders transmission of negative acquisitions retrogressively possible. Individual and racial existence are thus curtailed. Induced parasitism —quantitative and qualitative—affects reproduction deleteriously.

80. Under an utter disregard of qualitative analysis, the title "Determination of Sex" has been applied to crude experiments producing (parasitic) antithesis. The case of a larva destined to become a worker, but converted into a queen, illustrates how the teleological status is affected by nutrition.

81. Organic structure and organic beauty are criteria of the legitimacy of sexual developments. Chemistry illustrates how accelerated developments must be avoided, and laws of distance complied with, if desirable growth is to be obtained (beneficence of osmotic processes).

82. Similarly, with organic beings, the good effects of fertilisation hinge upon the legitimacy or otherwise of antecedent assimilative conditions.

83. There is but one legitimate mode of nutrition for every true-breeding organism. Surfeit is incompatible with true breeding and causes antithetic developments.

84. Self-fertilisation in plants is equivalent to limitation of life. Crossing implies the accession of increased inner capacities, an advantage which is shown by the

greater constitutional vigour exhibited by cross-fertilised plants.

85. The superabundant (and apparently wasteful) production of pollen in order to achieve cross-fertilisation represents work done by a species (sacrificial efforts) towards the upkeep and advance of teleological status. *Linaria vulgaris* is a good example. The crossed plants in Darwin's classical experiments proved more vigorous (dynamico-teleological advantage) than the self-fertilised. "Bees incessantly visit the flowers of this Linaria" (teleological = biologico-economical value attaching itself to wholesome and reciprocal affinity) "and carry pollen from one to another."

86. Artificial self-fertilisation lessens productive value, and is accompanied by sexual antithesis. The anthers, after a few generations, are the first to show marked symptoms of degeneration. The pathology of self-fertilisation is outwardly manifested in structural disorganisation, as witnessed in monstrosity and dimorphism (general antithetic development).

87. Self-fertilisation may have apparent advantages. Like its equivalent parasitism, it is not prejudicial to size and numbers. Crossing entails reproductive necessities and sacrifices, which cannot be discharged, or are no longer of avail, when morbidity has exhausted potential

88. The "misère physiologique" of cleistogamic flowers is the complement of their parasitic fecundity.

89. Competition constitutes a test of superiority. Absence of restraint in many instances proves fatal.

Lack of self-restraint and dysteleological behaviour generally determine the degree to which organisms are drawn into competition. Certain trees "clean" themselves and protect themselves against parasites.

90. Sexual compatibilities are largely determined by assimilative conditions. Reduction of surfeit and of innate defects is a prerequisite of useful crossing.

91. The "misère" and sterility of seedlings resulting from the union of "illegitimately" self-fertilised cowslips is due to infringements of the law of growth. "Favourable conditions" mostly spell indolence, impurities, surfeit, and sexual illegitimacy. Obversely, a return of "unfavourable conditions" generally means a restitution of normal modes of life. It is under normal conditions that the superiority of legitimate unions is most evident. Where extrinsic stimuli predominate, the resulting diminution of potential may for a time escape notice.

92. Darwin's experiments show that in retrogression retrograde compatibility is the alternative to sterility.

93. Domestication is generally equivalent to an induced parasitism—the former teleological adjustments and checks being withdrawn.

94. The offspring of self-fertilised plants are more susceptible to acute disease than those of cross-fertilised. The appearance of persistent colours at the end of several generations of self-fertilisation marks a definite point of retrograde metamorphosis. The extraordinary cases in which pollen from the same flower acts on the stigma like a poison, is the physio-

logical analogue to the exaggerated forms of animal antithesis, which culminates in sexual cannibalism.

95. The efficiency of pollen, as its chemical constitution indicates, is largely determined by metabolic processes of the plant. Inability to achieve cross-fertilisation, with contrasts of size and numbers, often marks the nemesis of a parasitic or epiphytic diathesis. Prepotency of pollen is but part and parcel of general prepotency.

96. The economic value of plants hinges on their physiological integrity (teleological status), which determines the harmony of intra-organismal arrangements and the beneficent action or otherwise of extraneous circumstances ("usefulness" in the widest sense perpetually justifying their abundant existence). Parasitic plants without green leaves can only maintain herbaceous, soft, and short-lived stems, with at best isolated strands of wood and phloem tissue. Their intra-organismal arrangements lack co-operation and incline towards primitiveness. Accelerated and unregulated growth among *Coniferæ* is marked by low quality and reproductive wastefulness. Failing a regularisation of sustenance and of growth, parasitism must depend on an irregular and uncontrollable supply of "hosts," which renders existence increasingly precarious. The biological examples of antithetic numerical development throw light on the problem of population in general.

97. Mendelian "dominants" and "recessives" are explainable in terms of the dynamics of health. "Self-

ing" is illegitimate fertilisation, equivalent to parasitic propagation. Mendelian ratios refer to dissociation and elimination. The Mendelian premises require scrutiny.

98. Darwin's account of the perforation of the "corolla" by the bee demonstrates an instance of retribution resulting from dysteleological behaviour. Conversely, his accounts of insect usefulness in cross-fertilisation illustrate the point of view of desirable (teleological) reciprocities. Darwin, however, as he underestimated pathology, likewise underestimated teleology. His idea of usefulness is too crudely material and too relative. His work lacked teleological criteria and appreciation of the teleological significance of developments.

99. The parasitic diathesis, artificial or self-induced, renders the life of plants precarious. The injury of close breeding, contrary to Darwin's view in the matter, does depend on disease. Increased length of intestine, as exhibited by some domesticated animals, is expressive of the cumulative effects of a nutritive overflow.

100. The advantage of the separation of the sexes subsequent to a state of hermaphroditism, and the eventual need of transcending the state of dichogamy, are intelligible on the hypothesis of teleological requirements founded upon division of labour and mutual interdependence of life.

CHAPTER I

THE PASSING OF "NATURAL SELECTION"

"Let the reader reflect on the difficulty of looking at whole classes of facts from a new point of view."—DARWIN.

I HAVE before me, amongst other papers and works, an article on "The World of Life, as visualised and interpreted by Darwinism," by Dr Alfred Russel Wallace, in the *Fortnightly Review* of March 1909, where it is stated that: "It is perhaps for the very reason that Darwinism is so simple that it is so persistently misunderstood. Those who have gone through a long course of study in the anatomy, physiology, or embryology of animals or plants, very naturally think that a theory which can dispense with their work (though it is often strikingly supported thereby) cannot be of much value; while it often happens that those who have the most extensive knowledge of these departments of biology do not possess the special type of faculty that is essential for a full grasp of the great masses of facts which underlie and are essential to the actual working of the principle of evolution through Natural Selection"; and, further, a series of articles by Sir E. Ray Lankester in the *Daily Telegraph*, one of which entitled, "Darwin's Theory Unshaken," and beginning thus: "It seems ill-mannered, if not ill-natured, that this year of the centenary of Charles Darwin's birth should have been chosen by owners of anonymous pens in order to alarm the public mind with the preposterous statement that his celebrated and universally accepted theory of the origin of the species or kinds of plants and animals by natural selection, or 'the survival of favoured races in the struggle for life,' is undermined and discredited. Such a statement once coolly made in the public press is necessarily believed by a large number of uninformed readers, and like all calumny, is none the less relished by the foolish, and, for the moment, none the less harmful, because it is baseless." Yet, science aspires above all to truth, and it is undeniable that the evidence against "Natural Selection" is steadily accumulating. Always opposed on ethical grounds, the inadequacy of this formula is now increasingly borne out by recent progress in physiology, pathology, morphology, and palæontology. A full exposition of its most fundamental errors, in my opinion, however, was not to be expected so long as the cumulative and teleological significance of nutrition remained unelucidated.

In *Nutrition and Evolution* I have taken up and partly substantiated a critical position, whilst at the same time propounding a broader and more apposite theory, which takes account of the facts by which Darwinism sets so much store, but of much more also.

To return to the charge: Both Dr Wallace and Sir E. Ray Lankester, in upholding "Natural Selection," state that it means, in other words, "the preservation of 'favoured' races in the struggle for life." But preservation *per se* cannot be considered a criterion of genuine survival, and requires qualification. Even degenerate species, though dissociating, have been, and are, being "preserved" for very long epochs. It cannot justly be pleaded, as is sometimes done, that by their mode of life they have placed themselves *hors de combat*, for their reproductive history shows that they are frequently engaged in frantic, though belated, struggles to maintain their equilibria. They are the very types of organism involved in the "intra-organismal struggle," and we shall presently see that their case is at the same time typical of the extra-specific struggle—the encroachment upon one species by another.[1]

Still more objectionable is the use of the word "favour." Such allegorical language might have been pardonable in the first flush of Darwinism, but it cannot pass muster at the present day. Is it not painfully evident that this "preservation of favoured races" is at best only a paraphrase of the scriptural declaration to the effect that the Lord is mindful of His own?—a view which at any rate implicitly asserts that divine "favour" can only be won by a marked obedience to the divine will—by conforming to the laws of nature. Has not the time arrived to raise the whole controversy to a more scientific platform and to refer the various phenomena to the respective natural laws? The capacity to survive is a matter of health, and, like the latter, determined by definite laws, which require to be clearly set forth.

---

[1] Darwin himself, in affirming that his "principle" of Natural Selection "leads to the improvement of each creature in relation to its organic and inorganic conditions of life, and, consequently, in most cases to what must be regarded as an advance in organisation," vaguely concedes that, "nevertheless, low and simple forms will long endure, if well fitted for their simple conditions of life." He seems to think they are in a *status quo*. But how do they endure? and how long? Is not the proviso "if well fitted" begging the question?

It has already been charged against the Darwinian formula that it leaves us in the dark about the positive elements conducive to an "arrival of the fit,"[1] and hence certain objectors have termed it a "recurrent negation." As if to emphasise the shortcoming, in the article alluded to above, Dr Wallace states:—"Herbert Spencer suggested the term 'survival of the fittest,' as more closely representing what actually occurs; and it is undoubtedly this survival, by extermination of the unfit, combined with universally present variation, which brings about that marvellous adaptation to the ever-varying environment, which is an essential feature of every living creature which survives to produce offspring."

Here, then, we have mainly a negation accompanied by the more than doubtful propositions—of which more anon—that adaptation and reproduction *per se* are the tests of fitness.

---

[1] "Selection," says R. H. Lock (*Recent Progress in the Study of Variation, Heredity, and Evolution*), "whether natural or artificial, can indeed of itself have no power in the direction of creating anything new; its influence is destructive or preservative, but nothing more than this. The breeder keeps the new forms which take his fancy, and destroys the rest; that is the whole story."

The vastness of "facts" regarding natural phenomena —"numbers, variety, and intermingling of life-forms" —is next appealed to in defence of Natural Selection. Though facts are stubborn things, they frequently, however, present a different picture when differently arranged. To begin with, the fact adduced by Dr Wallace that "so comparatively poor a flora as that of the British Isles comprises about 1800 species (counting only the species and sub-species in Sir J. Hooker's *British Flora*), but probably over 2000 on the estimate of most local botanists," seems scarcely relevant to the argument of Natural Selection.

The subsequent evidence of the "somewhat close agreement in the variety of interrelated insects and plants in the same areas" indeed points to a law of interrelation between the animal and plant kingdoms, but it lends itself to an interpretation along the lines of co-operation rather than of struggle—an interpretation, moreover, which supplies the clue to the rationale of genuine survival, as we shall presently see. Dr Wallace further points out that "the larvæ of *Lepidoptera*, commonly known as caterpillars, almost all feed upon the foliage of living plants. Many plants support several species of caterpillars, while some of the commoner caterpillars will feed on several different though usually allied plants. Now it is very suggestive that the number of species of *Lepidoptera* and of flowering plants is very nearly the same—somewhere about 2000. Beetles, however, are much more numerous (3260 species), but these feed largely on decaying vegetable and animal matter, while many devour other insects."

Now the construction that I wish to place on these facts is to the effect that as soon as the law of animal alimentation is seriously infringed—as soon as animals habituate themselves to feed on animal instead of vegetable matter—multiplication of individuals and frequently of groups termed species proceeds at a dangerous and chaotic rate (pathologically), involving violent clashes—a struggle between organisms which is of their own making. This, of course, opens up the whole problem of reproduction as determined by nutrition, which I have essayed to elucidate in *Nutrition and Evolution*, and on which the ensuing examination of the Darwinian position and the chapters on reproduction will shed more light.

So far we have seen "Natural Selection" identified with the interchangeable doctrines of "the preservation of 'favoured' races" and of "the survival of the fittest," the unqualified criterion of "preservation" and "fitness" being reproduction and adaptation. It is necessary to add that it has latterly also been identified with the concept of "intra-organismal selection"—the struggle of parts within an organism. Thus, according to Sir E. Ray Lankester, the survival of the fittest alludes exclusively to the struggle within the borders of a race. In his *Kingdom of Man* he states: "The struggle for existence to which Darwin assigned importance is not a struggle between different species, but one between closely similar members of the same species." . . . "The struggle for existence takes place, not, as a clever French writer glibly informs his readers, between different species; but between individuals of the same species, brothers, sisters, and cousins."

But is it not straining the point to say that the struggle between different species (which, after all, are no fixed categories) is only a matter of a casual feud and of a different nature from that of the intra-organismal struggle? Is it enough to classify outside forces encroaching upon a species as "enemies" merely? Or must we not elucidate the respective affinities as based on definite interactions of life?

There must have been previous causes to account for an intra- as much as for an extra-organismal state of enmity, nor is it likely that they differ very much in kind. As regards the intra-organismal struggle, there exists indeed a gradation in the relations between brothers and sisters, from a fair division of duties to intra-specific competition, incompatibilities, and grave discords, culminating in internecine strife. But why should domestic and civic antithesis be the normal thing? Why should these relations be disharmonious? Why should a house be divided against itself? Sir E. Ray Lankester says because all the young have the same needs. But supposing Sir E. Ray Lankester's "needs" are abnormal needs, his mutually destructive brothers, sisters, and cousins, owing to previous transgressions of natural laws, courting the furies of retribution? The operation of this agency is by no means confined to the limits of a species; it is universal. The struggle within a species is but one of its aspects, and it is primarily determined, I contend, by a fundamental (metabolic) diathesis.

Let us for a moment adopt Sir E. Ray Lankester's line of reasoning. His view is clearly influenced by the Malthusian doctrine that a geometrical increase of population, by producing a maximum of identical needs, may eventually outrun the means of sustenance, and that, consequently, societies are doomed to a perpetual struggle to find a supply of food equal to the number of their mouths. In answer to this I affirm that the danger indicated by Malthus is in direct proportion to the tendency of certain individuals or groups to develop parasitic propensities; for such propensities can have no other effect than to produce abnormal metabolic ratios, immediate disturbances of distribution and prodigious multiplications. If such morbid tendencies must continually make for friction, for undue competition, and for struggle, we can set against them the potent operation of a universal process in nature favouring reciprocation and co-operation. The facts respecting the relations between the animal and vegetable kingdoms to which reference has already been made will make this point clearer. The plant stores up potential forces, which are converted by the animal to its own uses. "Nothing of the sort can be done," says Sir E. Ray Lankester himself, referring to the formation of starch and proteids by the plant, "by the protoplasm of an animal cell." "All living things are, in fact, ultimately dependent on the green plants—whether microscopic or of larger kinds—not only for food, but for oxygen gas. If you could take away green plants altogether from the world, the animals would eat one another and use up the oxygen gas of the atmosphere, and at last there would be a few only of the strongest left, like the last survivor of the shipwrecked crew of the *Nancy Bell*, and even they would be suffocating for want of oxygen." There is, then, an essential cosmic interdependence and reciprocity between animal and plant, which, if legitimately followed out, guarantees normal metabolic results. In other words, to the animal, plant-food alone supplies alimentation concordant with the requirements of stability, and alone prevents parasitic "needs" and parasitic (*i.e.* geometric) ratios of multiplication. Plant-organised food stimulates in a physiological direction, whilst animal food, being charged with katabolic emanations, stimulates in a pathological direction. It is in consequence of a neglect of legitimate alimentation that predaceous types, setting themselves against the most fundamental and sacred cosmic laws of assimilation and of division of labour, suffer an obliteration of all normal ratios of life, drifting deeper and deeper into morbidity and parasitism. It is thus that destruction and the "law of battle" become retributively operative.

It is quite clear—and many other considerations go to confirm this—that a mutually beneficial and economically significant metabolic ratio normally exists between plant and animal. It is equally clear that there is practically no limit to the extent to which the vegetable kingdom—given normal ratios in general—can draw on earth and atmosphere towards the support of animal life. Dr Wallace himself, on p. 414 of his article, points out that "the powers of increase of the vegetable world seem to us wholly beyond what can possibly be needed." It is thus indeed a characteristic feature of plant-life to produce a margin of seed capable of providing sustenance to the animal, which we may term a teleological margin, for it is an instance of the wider, cosmic usefulness of plants.

It also follows that animals, instead of wasting time and energy in fighting and depredation, or in the search for "hosts" for parasitic indulgences, might by furthering the interests of a bountiful vegetation almost indefinitely multiply their means of sustenance, while at the same time justifying and ennobling their existence. It was thus that in human evolution agriculture superseded hunting, and was not only conducive to nobler forms of existence and of brotherhood, to a reduction of all manner of parasitic nurture, to a diminution of disease and a perfection of intra-organismal (physiological) and, hence, social organisation, but also to possibilities of maintaining greater populations on smaller areas.[1] The very word "Aryan" is believed to be derived from a word akin to the Latin *arare*,

---

[1] As regards the savages, "it has been remarked," says Kropotkin, "that as soon as they succeed in increasing their regular means of subsistence, they at once begin to abandon the practice of infanticide" (*Mutual Aid*, p. 102).

"to plough," the Aryan people being thus distinguished from the nomadic, non-agricultural races, which did not attain to the integrity of their organisation. (It should never be lost sight of that all real progress and power—all genuine human wealth—were wrought along the lines of work and cultivation, as opposed to those of vagrancy, of depredation, and of parasitic nurture.)

If it be true that the "struggle between different species" is less common than that between brothers, sisters, and cousins, this may be primarily due to the fact that in the great cosmic division of labour every species has a particular metabolic significance, in the same way as, according to Darwin, "different plants require and consume very different amounts of inorganic matter," and that, hence, between well-defined species clashes are rarer than between individuals of the same species.

We should, however, expect the (supposed) interests of different individuals or species to clash—and this is only an intra-organismal struggle on a greater scale—wherever the particular natural metabolic ratios are disturbed, and indiscriminate, incessant, or carnivorous alimentation is instead resorted to. This is exactly what occurs. The greater the degeneracy, the more insatiable the "hunger," the more prodigious the multiplications, the more intense the pugnacity and the cry for "preserves" and for "hosts," the less possibility of a legitimate discharge of the particular metabolic obligations. Those types which, instead of regulating their metabolism according to cosmic requirements have developed an appetite for flesh or have indolently and illegitimately placed their dependence on an irregular and uncontrollable supply of "hosts," must lead the more precarious life, and be in constant danger of becoming "highly specialised," and of their supplies getting short. It is part of their fatality that they are often drawn into hostile and parasitic relations with other profligate organisms which have similarly strayed from the path of rectitude. Their appropriation is not in harmony with the universal process of co-operation and reciprocation, and, under the new retrograde adaptations, eventually becomes no longer amenable to the beneficent operation of this process. Instead of a regularisation of sustenance and of growth, they must subsist by murder and by stealthily getting the better of others, and in general by setting themselves in opposition to all progressive (teleological) forces in nature. This means instability, acceleration and curtailment of life-processes, retribution and nemesis. The facts, properly studied, show indeed that in all cases the "law of battle" has been led up to by what I have termed a parasitic diathesis—susceptibility to extraneous potencies induced by mal-appropriations, be they organic or inorganic. (This definition, of course, assigns a wider significance than is usually accorded to the term parasitism, which here connotes not only every form of semi-parasitism, but even the inceptive stages of the disease.) The universality of this cause is strikingly testified to by the widespread prevalence of diseases, identical in their symptoms and concomitants, among entirely different species and even orders.

A very pertinent objection to the current notion regarding germinal "selection" is impartially, though far too tentatively, admitted by Professor A. J. Thomson in his *Heredity*. Says he: "Yet, is not the supply of food brought by the vascular fluids of the body always more than sufficient?" This is the crux of the whole matter. We might cogently paraphrase the question thus: Is not the "favour" shown by nature to all her organisms always proportionate to their deserts? The reply to Professor Thomson's query is that normality or otherwise in the germinal food-supply depends on the degree of legitimacy by which the aggregate specific nutrition is characterised.

"Cells," says Sir E. Ray Lankester, "do in their small microscopic way all that the complex, big animal or plant, of which they are constituents, is seen to do," and he shows that subordination of the parts to the whole is one of the prime conditions in the life of a synthesis which we call an organism. It remains to be added that a certain amount of justice on the part of the body's central authority is constantly required to preserve a healthy balance. Normally the protoplasm of the cell is possessed of a power of discriminatory absorption. It is pointed out by Professor E. H. Starling (*The Fluids of the Body*, p. 60) that "the cells of the intestine, besides their attraction for water, have the power of picking up out of the intestinal contents those substances in solution which represent the normal food-stuffs of all the cells of the body." So long as this protoplasmic instinct is unperverted by a disharmonious "life," absorption and distribution are normally and beneficently determined. It is well known that the development of both the circulatory and nervous systems depends intimately upon that of the digestive system. The moment, however, appropriation becomes abnormal—with parasitic as opposed to normal requirements—physiological integrity and co-operation must go to the wall, some organs or bodies grow surfeited, predatory, and dangerous.

Undoubtedly the current confused concepts as regards "selection," with its imagined rigid efficacy, were a great bar to the recognition of the pathology of parasitism, for we find it stated in the *Encyclopædia Britannica* that parasitism is "by no means an aberration," but "only one of the many cases in which the influence of environment on organisms is clearly marked." It was fondly imagined that, with an inexorable law of "selection" at work behind the scenes, a state of real retrogression could not possibly result. Everything, indeed, had to be explained into a "sound" adaptation. Parasitism may be otiose, but at least it is "sound," so it was declared.

Here we are face to face with the gravest objection to "Natural Selection," which is worth considering a little further. The science of pathology, though it has as yet failed to enunciate the precise nature of the respective susceptibilities, is demonstrating more fully every day that disease is a matter of parasitic affinity. Nearly all diseases are now believed to be due to a microbe of some kind, which, by its poisons, undermines the constitution and frequently causes abnormal growths. It only requires a step further to recognise that some inherent form of parasitism on the part of the afflicted organism itself is the cause of the affinity. Leaving aside misleading evidence, the large facts, indeed, are obvious. It is thus, for instance, well known that fungi, which live at the expense of living plants, are incapable of successfully attacking one which is completely healthy. All that excessive drought or moisture, or anything else that weakens a plant, can do is to render it powerless to resist attacks of germs, which in most cases are incapable of penetrating sound and healthy tissue. In plants as in animals, however, the nutritional states largely determine the beneficence or otherwise of tissue developments. It is necessary to remember that an organism is a more or less autonomous living creature, to a great extent master of its own fate, and as such responsible for innumerable interactions and affinities, amongst all of which, however, physiological ones, as the most persistent and recurrent, must take first place. Cope, the American palæontologist, indeed attributes the majority of facts in evolution to conscious or unconscious physiological actions. The attractions involved in disease may, in a somewhat rough and ready manner, be expressed in Swift's words :—

"Great fleas have little fleas,
And lesser fleas to bite 'em,
And these fleas have other fleas,
And so ad infinitum";

or in more prosaic language: parasitic affinity represents a reaction from parasitic activity. Sir E. Ray Lankester points out (*The Kingdom of Man*) that "the relations of parasites to the organisms upon or in which they are parasitic, and the relation of man, once entered on the first step of his career of civilisation, to the world of parasites, form one of the most instructive and fascinating chapters of natural history. It cannot be fully written yet, but already some of the conclusions to which the student is led in examining this subject have far-reaching importance and touch upon great general principles in an unexpected manner." I contend that parasitic affinity is a matter of action and reaction, and there can be no doubt whatever that the primitive mode of life of most groups of parasites was one of complete independence. It will be objected that the extermination which plays so formidable a part in Darwin's Natural Selection refers to phenomena altogether different from those of disease. But a little consideration will suffice to show that the distinction is superficial, not real.

Dr Wallace himself points out in his article (p. 416) that the progeny of three flesh-flies could devour a dead horse as quickly as could a lion. In like manner must we assume that the exterminations caused by interior parasites and all manner of rapidly increasing micro-organisms are by far the most substantial factors of elimination. When we allegorically speak of the "ravages of disease," we should remember that, according to Sir E. Ray Lankester, there are as many as thirty distinct kinds of bacteria producing putrefaction or other chemical change in the digestive canal of man alone—" and their quantity is gigantic. They pervade the whole contents of the human digestive canal by millions." In comparison with such "ravages," the picture of "Nature red in tooth and claw" pales into insignificance. The study of the evolution of disease thus goes to show that we are justified in classing almost every form of extermination under the head of elimination—analogous to the rejection of superfluous material in chemical processes, when once the requirements of stability (as expressed by laws of definite proportions) have been satisfied in a particular combination. (The definite groupings and "selections" of the atomic world may be considered as an adumbration of the crystallisation and concomitant rejection of superfluities—purporting organic beauty and organic integrity (teleological adaptation)—made use of by every kind of living growth, individual or aggregate.)

The synthesis, called a species, as it is in constant need of renewing itself by means of nutrition and reproduction — the combined exaggeration of which functions provides the point of view of pathology—is also in constant need of eliminating superfluous materials and impure strains ("recessives") deleterious to its stability — derogatory, we might add, to its teleological status.

Very cogently has it been said that the clearest definition we can give of dying, is to say of an organism that its processes now go on no longer teleologically, but only causally. The difference of processes in the dead horse above alluded to as being rapidly devoured by the accelerated reproduction (under a parasitic diathesis, be it remembered) of the flesh-fly, and the pathological processes afflicting a living horse suffering from a lingering parasitic infection, is but one of degree. The difference of enmity between the horse and carnivorous beasts on the one hand, and pathogenic organisms on the other, likewise is but one of degree. Viewing the matter broadly, *sub specie æternitatis*, as it were, we may say that it is dysteleological function (and here we are principally concerned with assimilative function) on the part of a species which leads up to dissociative—*i.e.* disease—or intra-organismal struggle or enmity-producing effects.

The difficulty of reconciling the facts of pathology with the hypothesis of "Selection," is apparent from the following statement made by the eminent botanist Strasburger:—"Many naturalists indeed have gone so far as to affirm that only the less advantageous qualities have been affected by the struggle for existence, while the advantageous have been uninfluenced by it." This is only another way of saying that the phenomena generally and vaguely associated with the concept of "Natural Selection" must be referred to pathology and aberration.

The atomic conception of elimination which I have commended is indeed corroborated by the teachings of the new science of Mendelism, and this corroboration I consider to be the chief message of Mendelism to our age.

No less important than the strictly pathological objections to Natural Selection—and indeed essentially correlated—are those of a morphological nature.

Thus J. T. Cunningham, in his *Sexual Dimorphism in the Animal Kingdom*, rightly points out that "the view that specific characters are of some use or significance in the struggle for existence is in a vast number of cases unsupported by any evidences." Or let us take the case of the Mollusca as illustrating the failure of Darwin's "Sexual Selection." In Darwin's opinion, in the sub-kingdom Mollusca, secondary sexual characters, such as he considered in *The Descent of Man*, never occur. He admits, however, with his usual candour, that there is as much beauty of colour and form in Mollusca as in any other sub-kingdom. Cunningham observes in this connection:—

"The colours in Mollusca, according to Darwin, are probably the direct result of the nature of the tissues and the manner of growth. It is strange that he did not see that this view would harmonise with all the facts of sexual dimorphism, and a great many others, provided it be added that the 'manner of growth' is affected in determinate ways by determinate conditions. Whereas on the selection theory we must explain the brilliant colours of a cock pheasant's plumage by the taste of the female, and the equally beautiful colours and markings of a Nudibranch mollusc by the nature of the tissues and the manner of growth, a more rational view regards both as due to the physiological processes of growth and secretion modified by external forms of energy."

If hitherto pathology has not been properly treated as a chapter of biology, it is that physiological habits and causes have scarcely been thought worth serious study. Owing to such omission, a demonstration of the dynamics of biological developments could not have been undertaken. Cunningham, though probably not appreciating the deeper significance of his remarks, pertinently observes: "So long as the minute study of habits and conditions of life is generally regarded as of little importance, so long will the collection of specimens and the discovery of species be considered the chief objects of zoological expeditions." But a mere multiplication of "nature-knowledge" cannot compensate for a lack of understanding of the fundamental principles associated with habits and conditions. Darwin himself has set a bad example in confining pathology and retribution as almost negligible quantities to the region of the indeterminate. The chief determinants in the dynamics of growth as already apprehended are the physiological factors—a defective metabolism constituting the general cause of degeneracy and of retribution. To this day, however, the physiological basis is receiving but scant justice.

Even Cunningham, who takes up an independent position, and who, as regards sexual "selection," rightly demurs to Darwin's incongruity in taking it for granted that "variations occur which are limited to one sex, in other words, which are transmitted only to individuals of that sex in which they occur," fails to see that these dimorphic phenomena are connected with a defective metabolism, as effect with cause.

The same morphological objections are constantly arising in palæontology where monstrous forms of canine teeth and of other bony or dermic productions are concerned. "We have really a right to ask ourselves," says Ch. Depéret in *The Transformations of the Animal World*, "of what use could such cumbersome weapons be to these animals?

"From the standpoint of the Darwinian hypothesis it would be logical to attribute to the struggle for life the survival of all these forms, either very well adapted to their functions, or very well armed for attack and defence; and one might even be brought to see in the struggle for life the fundamental cause of the progress of the specialisation of the organs in a given direction. It would, therefore, seem *a priori* that the phyletic branches most capable of preservation must be those whose mutations most rapidly reached a great stature, an adaptation perfect for their wants, and a powerful offensive or defensive armament. We shall see, a little later, when studying the causes of extinction in species, that the problem is far from being so simple, and that a too advanced degree of specialisation, however useful it may seem to be to the animal possessing it, is, on the other hand, generally a cause of decline and of death."

Palæontological evidence thus unmistakably points to the fact that antithetic monstrous or teratological developments—"too advanced a degree of specialisation"—are dysteleological features; and Dr Wallace can hardly accuse me of special pleading or of leaving the time-element unconsidered when I set the very development of such high "specialisation" down to a cumulative parasitic diathesis which, as it implies precarious and retrograde adaptation of function, is *ipso facto* responsible for an unbeneficial structure.

Instead of elucidating the causes of morphological distortion as mainly consisting in a defective metabolism, our biologists incline to fight shy of the "slippery basis of metabolism." The alternative tendency is to dogmatise on matters of "selection" and heredity, notwithstanding the pregnant warning of Huxley that "Science commits suicide when it adopts a creed."

Although experiments of the class of Schmankewitsch's with brine-shrimps (*Artemia*)—showing to what a startling extent organisms may undergo transformation through change of nutrition—are fast multiplying, Professor Thomson will have none of it; he opines that "perhaps the altered salinity simply pulled the trigger of variability," an ingenious way of allegorising the effects of nutrition.

In *Nutrition and Evolution* I have endeavoured to show in greater detail that pronounced sexual dimorphism and antithesis of size in general are due to exaggerated nutritive function, which implies retrogression in organic structure, and is invariably accompanied by accelerated but retrograde multiplications.

What is true of antithesis of size is equally true of antithesis of numbers. The "Powers of Increase of Plants and Animals," to which Darwinists attach so much importance, are no eternally fixed quantities, but they are abused and prematurely exhausted in all cases where a defective metabolism is operative. Extravagant generation is the unfailing precursor, just as extravagant morphological development the unfailing concomitant, of extinction. Both result from a parasitic diathesis, the particular organism or species having entered a path of pathological affinities full of danger to themselves and to other beings.

The plea, sometimes advanced, of utility and genuine adaptation in parasitic multiplication, is certainly indefensible. To say that parasites multiply fast with a view of decreasing their chances of extermination is preposterous. In point of fact, parasitic multiplications proceed fastest when the food-supply is the most secure. The real danger comes from within—a bad choice of adaptation spelling acceleration of life-processes and precariousness of existence in general. Extermination threatens in many cases when the host is all but devoured, but it can hardly be demonstrated that the anticipation of such imminent danger animates the parasite to change its modes of life. Sheer necessity, however, frequently and for a season puts a stop to parasitic indulgences, and produces a recovery in an organism otherwise degrading to the pathology of a mere feasting and reproducing automaton.

To say that the phenomena of parasitism must not be treated as aberrant, and that we have to do with only one of the many cases in which the influence of environment on organisms is clearly marked, is on a par with the old anthropocentric belief that everything was created for man's use. That such fallacies could persist so long should certainly be a warning that the legitimacy of teleological argumentation must depend on the universal validity of its premises. If parasitic multiplications can be shown to be pathologically accelerated, it is as vain to pretend that the parents in their excessive propagations are genuinely concerned with race-preservation, as it is erroneous to conjecture that everything exists for whatsoever organism to "adapt" itself upon.

Again, if nutritional excesses universally have the effect of unduly accelerating organic life-processes, it is obvious that we are here dealing with a fundamental and universal force, teleologically important. We are entitled to the conclusion that wherever the force of nutrition is abused, reproduction likewise must become cosmically disharmonious, *i.e.* charged with "selective" or explosive elements, both intra- and extra-specifically considered. The becoming extinct of a species may thus be defined in the same way as the dying of an organism: its processes no longer go on teleologically, but only causally.

Now, speaking of "The Powers of Increase of Plants and Animals," Dr Wallace has the following passages:—

"One of the most important factors in the development of the world of life, from its first appearance to the present time, has been the power of increase possessed by every species of organism. This is best shown in plants, and in some of the lower animals, in which the possible increase of a single pair is not four- or five-fold, as in some of the higher animals, but usually many hundred- and often many thousand-fold."

"Turning to the animal kingdom, we still find the reproductive powers always ample and often enormous."

Such statements, however, are too highly generalised to be of much value. In all cases it remains to be seen how far the various phenomena of reproduction are pathologically affected and attended by dissociation (loss of intra-organismal energy). Instead of treating reproductive powers, "always ample and often enormous," *en bloc*, we must discriminate between—

(*a*) Normal propagation, as associated with legitimate assimilation—here the powers are "ample" and sufficient to produce "dominance," though on an unaccelerated rate of increase;

(*b*) Abnormal and accelerated propagation, as resulting from a parasitic diathesis—here multiplication runs riot at the cost of gradual disaggregation and loss of potency;

(*c*) Exhausted propagation, the sequel to (*b*)—here a species is approaching the goal of extinction, its processes having ceased to be of any teleological value. In other words, the resultant of the particular organic system has turned negative.

It is most essential for a true appreciation of these distinctions to take the time element consistently into consideration. Dr Wallace justly reminds us that 750 years represent but a few moments in the geological history of the earth. To the question, however: What is the sequel to an "enormous power of reproduction" when pathologically exaggerated and when long periods of time are considered? Biology makes answer:

Degeneration, attended by various phenomena of dissociation, by monstrous forms and antithetic developments in general.

Palæontology answers:

Coral islands, foraminiferous rocks; teeth, bones, and skulls of abnormal size and structure.

It is evident that a morbid acceleration of growth in the long run spells curtailment of "length of days," both individually and specifically. This is strikingly borne out by the study of heredity under parasitism, especially in the innumerable vicissitudes of pædogenesis and parthenogenesis, where we frequently see death intimately linked with reproduction, and one generation at the moment of birth ready to give birth to another generation.

Parasitism is synonymous with self-limitation. As the evil increases geometrically, a constantly decreasing equilibrium can be but feebly maintained, even with belated and often frantic reproductive sacrifices.

In the precocious reproduction of the larvæ of the well-known fly, *Chironomus*, the production of young is fatal through successive generations. In many instances the mother-animal is sacrificed in reproduction, and frequently the exhaustion is fatal to the male.

In all cases where heredity is distorted and reproduction is marked by precocity, we may conclude that generic life is an unstable quantity, and for the greater part worthless in respect of reproduction. It is thus that certain genera of the *Insecta* (Ephemera, Strepsiptera, Bombyx, etc.) are in the mature state wholly destined for generation or reproduction, incapable of taking any nutriment—the duration of their life being very brief. It is the larvæ that carry on the generic tradition, their most striking characteristic being voraciousness.

Phenomena of the same kind, though differing in degree, characterise the history of cultivation and domestication. When a particular type of plant or animal has for a period been exploited to gratify human needs, or frequently human appetites and fancies, an induced parasitic diathesis with all its usual concomitants results. In course of time deterioration and defacement of such a species become very apparent, and another type is "preferred," the former medium of human gratification either returning to pristine obscurity or becoming prematurely extinct. It is thus that, among cultivated plants, geraniums may supersede camellias, only in return to be superseded by begonias, which in their turn are already observed to be losing in grace and beauty as they gain in size. What happens frequently is that the stalks are too weak to support the heavy flowers—a fact highly symptomatic of the antithesis between pronounced reproduction and survival-capacity.

Evidently preservation *per se* is not the desideratum. Moreover, it is well known that cultivated plants usually exhibit greater variability than naturally wild species, and this is what, on the view here propounded, we would expect, the case being analogous, as coming under one and the same diathesis, to that of the beetle tribe (previously referred to), which, owing to many of its species feeding on decaying animal matter, *i.e.* abnormally, distinguish themselves by an extravagant number of species.

Similar phenomena obtain in the history of domestication. Prehistoric skulls point to a breed of cattle, long since extinct, which must be separated from existing breeds. They became extinct *pari passu* with the development of giant forms. The evidence as regards domestication is (see Professor James Wilson's *The Evolution of British Cattle*) that in general the size of animals has been increased by man. "If the big-skulled animals of the pre-Christian era had survived, they would to-day be even bigger-skulled than in the time of Cæsar."

But the diathesis of domestication spells a loss of survival-capacity, and is little apt to secure "dominants"—bulls which "leave a good milking stock" or which win the sweepstakes at a particular show. Man, however, wants "dominants" at any rate in his cattle. He is bent on having the best at least where his culinary comforts are concerned. A fixed capacity for fat-production in milk, a fixed capacity for giving fat meat, a fixed character of skin as desired, a short or long face as desired, a fixed type and shape of rump, and last and "most important of all!" a robust, germ-resisting constitution—such are man's rather exorbitant demands regarding his animal "hosts"—such are the boons which, it is now expected, the new science of Mendelism will confer upon him. Why certain characteristics are "dominants" and others "recessives" is a mystery "that has yet to be attacked." In *Nutrition and Evolution* I have shown that the various Mendelian phenomena can be rationally accounted for in terms of health and disease.

Professor Wilson surmises, as regards the arrival of "dominant" bulls, that it takes place when the development of the animal tends to be "on lines which withdraw power from mere external expression in order to concentrate it on building up more strength and power within the carcase," which is indeed an adumbration of the view that dominance and preservation consist in health as symptomised in structure.

Is it then, in the light of pathology and of the time-element, legitimate to base arguments in favour of Natural Selection on the vague proposition of the "almost incalculable powers of increase of every species"?

Dr Wallace points out that the slowest rate of increase may be sufficient to keep up the greatest population "when the conditions of life are otherwise favourable." This is a proposition altogether different from the one above. It refers to what I have classed as normal propagation. The true prerequisite of a slow and steady (teleological) rate—especially symptomatic of the highest types—is fulfilled wherever we have a legitimate metabolic basis.

I have added the word "teleological" to emphasise again the cosmic significance of every physiological process. Both Darwin and Wallace, indeed, deserve the highest credit for having incessantly pointed out the manifold instances of complex relations and interactions existing throughout nature. But this factor is of such universality that its precise value as applying to all developments must now be accurately determined.

Interaction between the most different equilibria is indeed a very potent factor in evolution, and where is this more persistently evidenced than in the dynamics of nutrition? A single species can no more feed nor multiply dysteleologically than any one organ of our bodies can consistently with the health of the total synthesis. It is the fundamental primordial and perennial connection between feeding and breeding, however, which is frequently overlooked, although Herbert Spencer has already maintained that every other property or function of an organism is only a simple extension of the nutritive property.

Vastness of numbers and of geological moments all require due consideration, but they can receive their true setting only when the significance of metabolic factors is duly comprehended, as the case of the

American bison and the American Passenger pigeon recounted by Dr Wallace again well illustrates:—

"In the early part of the nineteenth century the ornithologist Wilson gave a wonderful account of them. One of their breeding places in Kentucky was a tract of forest forty miles long and several miles wide, and in this space (in April and May) almost every tree was crowded with nests, both on the higher and lower branches. The parent birds daily roamed the country to a distance of nearly one hundred miles for their food and that of their young. Wilson describes one of these great flocks on its daily excursions as being more than a mile wide and of very great depth, in the air far above gunshot. They flew with immense speed—50-60 miles an hour—and the stream went on for several hours before it diminished in density, and some hours more in straggling parties. He calculated, roughly, that this one flock, going to and from one breeding place, contained about two thousand millions of birds, and this was only one out of many such aggregations known at that time in the United States."

If Darwin has chosen to call such comparatively harmless, herbivorous, grain-feeding, slowly reproducing types as these bisons and pigeons "dominant species," it becomes again strikingly evident that a "dominant" or "favoured" species is a race which excels through the legitimacy of its metabolism.

In Dr Wallace's own words: "It is an obvious fact that animal life of every kind depends on the vegetable world for its very existence, and it can also be easily perceived that it is on the overwhelming variety of plants that the corresponding variety of animals has been rendered possible."

It is equally obvious—though insufficiently recognised—that herbivorous and frugivorous races can exist and prosper on a minimum of germinal internecine and extra-specific struggle, for the clash of interests between brothers, cousins, and even the more varied members of the animal community must certainly be diminished when they all draw their food from an "overwhelming variety of plants," and thus give rise to a number of physiological (teleological) instead of pathological syntheses.

In Mendelian (or atomic) parlance, a Darwinian "dominant" species thus represents a synthesis containing fewest impure strains, with consequent least need of an exhaustive and costly extrusion of recessives and impure dominants; in terms of biology, its reproductions are the most perennial because the most economical—involving least need of abnormal or exaggerated embryonic food-supply, and *pari ratione* least reproductive nemesis. From the point of view of physics and dynamics the respective equilibria give least rise to excessive dissociation and (contagious) induction.

As regards the "germ-resisting" quality, on Sir E. Ray Lankester's own showing—he instances Metchnikoff's experiments on the large tropical fruit-eating bats, or "flying foxes,"—we may have "adult mammalian animals not very remote from man in structure, food, and internal chemistry, which are absolutely free from the intestinal parasitic bacteria which Metchnikoff supposes to cause poisoning and senile changes in man."

The *sine qua non* of such immunity, here as elsewhere, is a legitimate nutrition, in the absence of which a surgical removal of the lower intestine will be found to be but a miserable and dangerous expedient.

The whole "Selection" issue, then, apart from the vast logomachy in which it is entangled, resolves itself into one of health and disease, further confirmation of which may be drawn from the following of Dr Wallace's remarks:—

"For, let us consider what happens in one of those severe winters which occur only a few times or only once in a century, when even in our favoured climate the ground is frozen two or three feet deep, or buried for a month together in a vast snow-field. An enormous destruction from cold or absence of food then occurs among many of our smaller birds and mammals, but so wonderfully are they adapted to support life under these adverse conditions, that some (probably many in actual numbers) always escape, either from capacity to resist cold or from greater ability to procure food, or from having found shelter—and these "fittest" that survive rapidly increase during the succeeding summer, and their offspring, for the most part inheriting their "fitness," quickly stock the country with well-adapted forms."

In other words, healthy organisms have a better chance to endure and to benefit their species than weaklings. This nobody denies, and nobody ever has seriously denied. It is a lesson in pathology on a simple scale. Those organisms that have suffered themselves to become diseased have to struggle for their very existence, or, to transpose the same truth to the bigger scale, species and even genera from time to time require purification and elimination in respect of generic integrity and of teleological position. It is thus by no means chance of position merely, as is sometimes asserted, which determines extermination.

Even when Dr Wallace declares that "no living thing can continue to exist which is not sufficiently adapted to all the recurring phases of its environment, inorganic and organic," this can in the first place only mean that an organic synthesis which is not healthily composed must suffer the consequences of disease. But the selectionist has no patience with disease. Does not his theory conveniently imply that wild nature being "naturally selected" (and in so far as it remains unaffected by "man's *imperium in imperio*") cannot harbour disease? Even parasitism, though it may be otiose, on this view is declared to be "sound" —as sound a view as that which removes the intestine lest it should (owing to an avoidable illegitimate nutrition) contract germs of disease. The twisting of facts and of language to fit the theory of "Natural Selection" is pathetic. Thus we find Professor A. Thomson making the paradoxical and false statement

—repeated *ad nauseam* by a crowd of less responsible writers—that "wild animals in nature have parasites but no diseases."

Given the divine order of things as "visualised" by the selectionist, the extermination of many of the "most highly specialised forms of earlier times" could not but be "a necessary result of the process of evolution." If high specialisation of life came as a gift, a "favour" from the deity of "Natural Selection," by implication, He had also reserved Himself the right at any given moment and in true autocrat fashion to withdraw such "favour" which had in the meantime been fortuitously gained by a new "variation." How these "variations" first arose, Darwin did not attempt to explain.

Professor Thomson states that "Natural Selection may explain the survival of the fittest, but it cannot explain the arrival of the fittest." (Did it really explain the one, it should have no difficulty in explaining the other.)

When Darwin, however, tentatively suggested: "It may metaphorically be said that Natural Selection is daily and hourly scrutinising throughout the world the slightest variation," he was clearly only stating the theological aspect—scientific formulation of which he hoped in time to be forthcoming—of the fundamental fact that organisms which set themselves persistently against natural laws must daily—though in ever so slight a degree—suffer the consequences of disease.

Speaking of those "highly specialised forms," Dr Wallace informs us :—

"These were for the most part specialised in adaptation to local and temporary conditions of environment in an ever-advancing life-world; and when those conditions changed—when new and more powerful competitors or enemies were developed—these specialised and often huge and unwieldy forms could no longer exist. Thus it was, probably, that as birds and the larger mammalia developed, the flying Pterodactyles, and the huge Atlantosaurus and Diplodocus, with hosts of other reptilian forms, first diminished in numbers and then became extinct."

But adaptation as here referred to is a parasitic adaptation, which, when it had run its course—terminating in the exhausted stage of pathological multiplications,—was bound to succumb from inner decay, a slow process of extinction in which human agency was but accessory.

I will only instance here the top-heavy dodo, which became extinct almost as soon as it became known, and the great auk, of which Sir E. Ray Lankester states that it is very difficult to say why it died out, for it had not been hunted down.

Sir E. Ray Lankester's inability to find a simple answer to this simple problem, towards the solution of which the pathological studies of his eminent Parisian friend will, it is to be hoped, in time guide him, shows how involved and verbally entangled the whole "selective" structure has become. This is principally due to the non-recognition of pathological factors.

Recent discoveries, however, go a long way in support of my theories. Thus Sir E. Ray Lankester himself states in the *Daily Telegraph*, Nov. 13, 1909: "The last discovery about 'trypanosomes' is that of one in the blood of the African elephant, announced to the Royal Society this week by Sir David Bruce. It is a matter of great interest that a trypanosome has been found in a death-stricken herd of European bison. It suggests that one of the causes of the disappearance of the bison, both in Europe and America, may be the infection of their blood by trypanosomes, and that possibly, whilst a freely migrating and vigorous herd would not be extensively infested, a dwindled and confined herd may be more liable to infection, and that thus the final destruction of an already decadent animal may be brought about." But it must be added that the appearance of the trypanosome represents only a late phase of disease, the last link in a long chain of previous susceptibilities due to metabolic transgression. As so great an authority as Professor Lindsay, M.A., M.D. (*The British Medical Journal*, Nov. 6, 1909) declares: "The response of the organism is an element at least as important as the presence of the germ. In the future it may turn out that we shall be compelled to devote less attention to the seed, more attention to the soil."

The case of the cave fauna likewise deserves mention in this connection. Thus Professor C. H. Eigenmann, in his *Cave Vertebrates of America: A Study in Degenerative Evolution*, points out that the blind cave vertebrates form a very mixed faunistic group, derived from a variety of epigean ancestors. It appears, however, that "*a certain predisposition in habit* and structure must be present to enable a species to dispense with light and to live in caves."

He states that "Natural Selection cannot have affected the coloration of the cave forms, for it can be of no consequence whether a cave species is white or black. It would only affect the coloration indirectly in one of two ways: first, as a matter of economy, but since the *individual* is in part bleached by the direct effect of the darkness, there is no reason why natural selection should come into play at all in reducing the pigment as a matter of economy; second, Romanes has supposed that the colour disappeared through the selection of correlated structures, a supposition he found scarcely conceivable when the variety of animals showing the bleached condition was considered."

A reviewer in *Nature*, No. 2089, vol. lxxxii., of this work concludes that "possibly, after all, the inheritance or non-inheritance of acquired characters is largely a question of time, or, perhaps better, of the number of successive generations which have responded ontogenetically to the particular stimulus which evokes the character in question."

Although it is going beyond our present point, I would here state my humble opinion that acquisition and inheritance of characters (let us make certain they are duly "acquired" before postulating anything about transmission or non-transmission) is a matter of compatibilities determined by ancestral dynamics, by factors of physiology and of response, which are precisely the factors requiring study, in the place of verbally contrived puzzles of heredity.

Justly Ch. Depéret protests against certain conclusions of Darwin on the ground that as a palæontologist he confined himself to the study of degenerate types. "Darwin was very little of a palæontologist. The only fossil animals he had personally studied, and that with a very real talent—the *Cirripedes antifa*, *Balana*, and *Coronula*—form a group degraded in their adult state by fixation or parasitism, and but little fitted on that account to make any interesting contribution to the history of evolution."

The conclusions so far reached may now be briefly summarised as follows :—

(*a*) Preservation, survival, and adaptation *per se* are by no means criteria of fitness. The terms "selection" and "favoured races" are inadequate; what is approximately implied can be more appropriately demonstrated in terms of the dynamics of health and disease.

(*b*) The insufficiency of Darwin's proposition of Natural Selection is mainly due to an ignoring of pathological factors and to the problematical character of the Malthusian generalisation on population which contributed towards the formulation of his theory. Rate of increase in any species is primarily determined by the mode of nutrition—a factor of the greatest importance, but unaccounted for by Malthus and his school. As soon as the component part played by nutrition is adequately allowed for, the Malthusian fabric—representing Nature's necessities under antithetic (dysteleological) conditions of life, but by no means her normalities and possibilities, totters to the ground.

(*c*) Instability, disease, "high specialisation," extermination and extinction are primarily the results of exaggerations—dysteleological behaviour (surfeit and depredation) resulting in precarious and dangerous developments. The pathological state involved from the very inception of the first morbid yielding may best be described as a "parasitic diathesis," for it spells parasitic affinities with susceptibility to all manner of extraneous potencies. The course of a parasitic diathesis is marked by a fatal acceleration and subsequent curtailment of life-processes, by increased, precocious, and inferior multiplications, by a break-up of organic architecture with pronounced sexual dimorphism and monstrous structure in general, and by a succession of more or less regular and violent eliminations and extrusions—rejection of superfluous and unfit material.

(*d*) If the value of the various processes is to be adequately determined, we must take the factor of interaction of life, the time-element, and the aggregate of a species into account, and refer the latter in turn to the greater aggregate: the organic family as a whole.

It remains to be added that the scheme here commended by no means overlooks the frequent cases of recovery from disease, nor is it prejudicial to any one positive factor that can be adduced as contributing towards progressive evolution. It dissuades, however, from the fantastic postulation propounded by certain followers of Darwin, to the effect that nature with the advent of man has changed her rule, and that man, her "rebel," has formed an *imperium in imperio.* The best direct, *i.e.* palæontological, evidence is here entirely in my favour, and flatly contradicts such notions. Palæontology emphatically declares that nature has not varied its processes, however early the period in view. Nor is it true that man forms an exception in nature.

CHAPTER II

POULTON, DE VRIES, AND DARWIN

THE *Quarterly Review* for July 1909 contains a contribution from Professor Poulton entitled "Darwin and his Modern Critics."

The writer admits that at least some of the criticism was "well aimed." "Thus the argument that domestic races freely interbreeding together are essentially different from natural species separated by the barrier of sterility, and hence that the results of artificial selection supply no evidence of the origin of species by means of natural selection, was acutely felt by Huxley himself."

Darwin's attempt to base a theory of "Natural Selection" on what is vaguely termed human selection is certainly far from satisfactory. Had he duly allowed for physiological and pathological factors, he would at least have qualified the parallel very considerably. I have shown in *Nutrition and Evolution* that the barrier of sterility is in many cases due to incompatibility resulting from metabolic causes. In so far as man happens to "select" teleologically, he may indeed be said to act as an agent in a macrocosmic process; with such a reservation we might concede a distant and vague resemblance between the fate of species under man's direction and that under the macrocosmic hand of Nature.

But even allowing for the reservations which Darwin failed to make, his hypothesis still remains too vague to constitute a workable formula. I must therefore confess I am one of those to whom "the more intricate operations of natural selection still appear as foolishness."

It should never be forgotten, however, that in those years of storm and stress Darwin fought quite as much "for the right of free thought and free expression of opinion in science" as for his own opinions.

Professor Poulton states that "a careful study of his great works and of these letters shows how shadowy and unsubstantial is the vast pile of criticism accumulated since 1859"—which, if true, hardly redounds to the credit of modern thought and modern science.

Darwin's superiority over contemporary as well as succeeding workers, both as regards intimacy of knowledge and intuitive grasp of principles, however, is evinced in Professor Poulton's consideration of *Darwin and Evolution by Mutation.* In 1860 he wrote: "Please tell him (Professor Parsons) that I reflected much on the chance of favourable monstrosities (*i.e.* great and sudden variation) arising. I have, of course, no objection to this, indeed it would be a great aid, but I did not allude to the subject, for, after much labour, I could find nothing which satisfied me of the probability of such occurrences. There seems to me in almost every case too much, too complex, and too beautiful adaptation in every structure to believe in its sudden production. I have alluded under the head of beautifully hooked seeds to such possibility. Monsters are apt to be sterile, or not to transmit monstrous peculiarities. Look at the fineness of gradation in the shells of successive sub-stages of the same great formation; I could give many other considerations which made me doubt such view. It holds, to a certain extent, with domestic productions no doubt, where man preserves some abrupt change in structure" (to Asa Gray; *Life and Letters*, ii. 333, 334).

Darwin was a staunch upholder of the great principle that "Natura non facit saltum." He would, however, have found it easier to explain its apparent breakdowns had he been able to draw a proper line of demarcation between physiology and pathology. I have already indicated that the appearance of monsters ("favourable monstrosities") is the result of a long chain of (antithetic) pathological development, which necessitates new adjustments of equilibrium as it *pari passu* determines sterility and incompatibility.

Darwin pertinently hints that we have something abnormal in these "sports," but does not go so far as to identify it with pathology proper. He was intuitively aware that there was a teleological influence in reproduction tending to check pathological developments. He likewise knew from natural occurrences and factors of domestication that a kind of abnormal (pathological) preservation undoubtedly continues throughout] long periods, although to concede it necessitates the postulation of a frequent suspension in the "operation of natural selection."

We are further told: In 1862 "Sir Joseph Hooker, having written to Darwin on March 17, 1862, to say that 'Huxley is rather disposed to think you have overlooked *saltus*, but I am not sure that he is right—saltus *quoad* individuals is not saltus *quoad* species—as I pointed out in the *Begonia* case, though perhaps that was rather special pleading in the present state of science'"; and in a footnote Professor Poulton adds: "In this passage Sir Joseph not only replies to Huxley's criticism, but also cuts away the foundation of de Vries' conclusions from his interesting experiments with *Œnothera lamarckiana.* De Vries has certainly never shown that the individual mutations which he can multiply into strains in the shelter of the Botanical Garden at Amsterdam have the power to increase into new species able to hold their own in the wild state. Individual mutations have always been admitted: the origin of a new species by mutation has never been proved."

Again I must point out that the appearance of new forms is a matter of compatibilities which would have to be separately and analytically studied, and which, as we have seen, are largely founded on metabolic developments. Some appear teleologically (with least *saltum*), others dysteleologically (very conspicuously). It is evident that without a proper analytical method all generalisations based on isolated cases of prodigious occurrences are futile. Failing this analysis, Darwin sagaciously adopted a cautious attitude towards *saltum.*

As Professor Poulton says: "While no one had studied large variations so carefully, or knew the extent of their occurrence in nature so well, we must reckon with the fact that Darwin's deliberate judgment gave them no place in the onward movement of evolution."

In other words, the suggestion is that *saltus* belongs to the phenomena of the dysteleological order. That Professor Weismann is inclined to be of the same opinion follows from his statement that: "It is in regard to the necessity which exists almost everywhere for the co-adaptation of numerous variations of the most different parts, that the 'mutation theory' breaks down utterly. . . . Harmonious adaptation requires a gradual, simultaneous, or successive purposive variation of all parts concerned."

But such harmonious and teleological adaptation—which is characterised by symmetrical morphological developments—is the *sine qua non* of health, and, as already pointed out, health is not compatible with accelerated growth any more than with chaotic intra-organismal arrangements. Weismann's requisite of "purposive," however, is not fulfilled in parasitic adaptation which involves antithetic development, and in general a predominance of physical and chemical over teleological forces. His own "intra-organismal selection" theory, which does not make proper allowance for such abnormality, therefore breaks down as utterly as the mutation theory of de Vries.

Arguing further against the extreme de Vriesian claim—that "the origin of species is an object of experimental investigation"—Professor Poulton states: "If de Vries' evening primroses are new species, so are dozens of the artificially selected breeds of animals and plants—in fact, those very forms which, still freely interbreeding with each other after centuries of human selection, prevented Huxley from feeling entire confidence in the power of natural selection to create fresh species."

I have already shown that the diathesis generally produced by domestication, as it is apt to cause prodigious morphological phenomena, also may give rise to new compatibilities, and this argument cuts away the ground from under the "selection" and the "mutation" arguments alike, both of which are entirely regardless of the factors of pathology and of inner response. Without due allowance for these factors and the time-element a proper analysis of developments cannot be made, and hence the conditions laid down by de Vries as necessary in biological experiments, have hitherto never been fulfilled. The following is his definition: "Experiments are a repetition of things occurring in nature with the conditions so guarded and so closely followed that it is possible to make a clear analysis of facts and their causes, it being rightfully assumed that the laws are the same in both cases."

Professor Poulton next indulges in the following strictures: "It is of the essence of a species, whether new or old, that it should be capable of withstanding the competition of nature; and, until de Vries has shown that his strains of *Œnothera* possess this power, it is premature to speak of them as species. Some of them were found by de Vries in a field at Hilversum, in Holland, growing in small numbers side by side with the parent, *Œnothera lamarckiana*, itself a garden escape. It would be a legitimate experiment in studying the origin of species to increase the numbers of some new form by artificial restriction of competition and then turn it loose, thus exposing to natural conditions immense numbers of individuals, and giving nature, as it were, increased opportunities for the rapid creation of a new species. But in any such experiments it would be more satisfactory to employ forms which have sprung from species of which the history is thoroughly known, rather than offshoots from the problematical *Œnothera lamarckiana*, as yet untraced with any certainty in the wild state.

"To raise fresh strains under artificial conditions affords far less evidence as to the mode of origin of new species than to study the actual succession of species in time, as revealed in the records of palæontology, or the changes of varied degrees which become manifest when we investigate their geographical distribution in space. In both these departments of knowledge we have before us the modifications which have actually occurred under the conditions of living nature. In de Vries' interesting and important experiments the most essential element in the problem of the origin of species is, *ex hypothesi*, excluded. His method can never demonstrate what forms would have been selected by nature; palæontology shows us what she has selected, geographical distribution what she is selecting."

Professor Poulton is thus rightly demanding, although not supplying, a profounder test, a profounder (teleological) rationale of survival. He hints at the possibility of a suspect "history" of the now famous *Œnothera*, and at the importance of the time-element generally. We may in that case be, unconsciously, dealing with an organism of a very unstable and chequered history, presenting phenomena of the dissociative order. Pathological and unstable states, notwithstanding astounding distortion and denial of facts, do persist even in wild nature and for considerable periods. In the same way latent pathological strains may under given conditions become acute and impart the most varying and prodigious tendencies to a system. The only valid test of survival is thus the test of health (the teleological test). When it is properly applied, however, both "mutation" and "selection" theories are very soon seen to disappear as the products of futile imagination.

It has been seriously contended by competent scholars that such gradual and continuous change as witnessed in the evolution of the horse, for instance, is inconsistent with an interpretation based on the theory of natural selection.

In answer to this Professor Poulton actually, though too tentatively, adduces a test of health—the teleological rationale. "All we can expect to find, as regards any character that exhibits progressive improvement, is evidence consistent with the belief that the individuals of each horizon were, upon the whole, descended from the more highly endowed and not from the less highly endowed individuals of the horizon immediately preceding it in order of time. And this is precisely what we do find when the record is complete."

Surely, however, this evidence is no proof of "Natural Selection," though of course, by means of dialectics and metaphorical language, almost every fact can be twisted to fit in with Darwin's principle. Nor is "endowment" a matter of "Natural Selection."[1] "Endowment" (a term which in this instance has proved dialectically convenient) is a result of response to stimuli from without, or, if it is to be limited to a definite physiological sense, a matter of health. That the more highly "endowed" show more promise of "progressive improvement" is thus a truism, or, at best, a matter of physiological laws—laws, moreover, that can always be relied upon in their operations, which is more than can be said of the slippery though very accommodating "principle" of "Natural Selection." It is indeed ludicrous in the highest degree to speak of Natural Selection being "most actively at work" (p. 21) here, and "least operative" there. Is the principle of action and reaction more operative in one place than in another?

---

[1] Reference has already been made to Strasburger's opinion that the advantageous qualities have been uninfluenced by "Natural Selection."

Whilst engaged in anatomising de Vries, Professor Poulton incidentally makes the daring but sophistical attempt to belittle the "response" argument. "When we study the records of life and its changes preserved for us in the archives of palæontology and geographical distribution, we fail to find any evidence of an evolution urged from within the organism by the periodic mutations suggested to de Vries by his experience with a single problematic form—*Œnothera lamarckiana.* Wherever, as on the floor of the deep ocean, conditions have been stereotyped for the longest periods of time, precisely there have the organisms themselves been longest stereotyped. Yet the relatively simple conditions of such scantily peopled areas are just those which would admit of an evolution by mutation without selection, if such evolution were ever possible."

If poverty and failure of response have conditioned a corresponding poverty of environment to certain lowly types, it is putting the cart before the horse to say that "conditions have been stereotyped." From the point of view, therefore, which considers the topographical position of animals as teleologically determined, Professor Poulton's argument appears illegitimate, and the environment alluded to as "suspect" as the "history" of the de Vries' *Œnothera.*

For the purposes of analysis each of these "less crowded areas" must be studied on its merits. One is not the precise equivalent of the other, and the long persistence or otherwise of organisms and organs is, in my view, a matter of more or less dissociation, which would have to be separately studied in each case before generalisations are permissible.

Professor Poulton further states that "many animals and plants possess the power of adjustment to two or more environments. In such cases the stimulus provided by one environment will cause an individual of the appropriate age to respond by the production of certain adaptive modifications, while the stimulus of a different environment will evoke in the same individual an entirely different and equally adaptive response." This is an "endowment" founded, as we have seen, on response and teleological development generally, which make for power *vis-à-vis* the environment, whilst dysteleological behaviour spells curtailment of life and limitation precisely in this matter of sufficiency of response to environment.

The interpretation of "self-adaptation," however, will not satisfy Professor Poulton, and he here actually falls back on de Vries' critical position (*vis-à-vis* to Darwin), which latter is neatly summed up by Sir W. T. Thiselton-Dyer in *Nature*, 2115, vol. lxxxiii.: "The utility of specific characters (p. 65) and adaptation necessarily go by the board as well. Desert plants are not adapted to desert life. 'They endure the desert, but only with difficulty' (*Plant Breeding*, p. 350); 'the spurs of the orchids . . . have not been originated in the way in which plants are now using them' (*l.c.*, p. 352). It must be admitted that all this is perfectly consistent, and follows logically from the conception of the species as an arbitrary result, 'independent of the environment,' and for which 'we can as yet assign no cause' (p. 130). This makes a pretty complete sweep of the Darwinian theory, and practically takes us back to the position of Linnæus, who was content to suppose that species were created. It must, however, be put to de Vries's credit that he makes an heroic attempt to save Darwin himself from the wreck by claiming him as at heart a mutationist (p. 87) who 'only by the pressure of criticism' (p. 39) gave up the true faith."

If de Vries, under an obvious twisting of facts to suit his "mutation" theory, makes the astounding statement that species are independent of the environment, he is at least modest in admitting that we can as yet assign no cause for his arbitrary "mutations." The moment, however, the cumulative (cause and effect) value of nutrition is fully understood and renders an analysis of ancestral dynamics possible, we cease to be puzzled by "sports" and "mutations," and no longer need that very "mutable" and accommodating "agency" of "Natural Selection."

Professor Poulton continues: "In addition to the evidence adduced above, certain weighty considerations of a more general kind strongly support the conclusion that, in such individual powers of adjustment to alternative environments, the ordinary operations of natural selection have been replaced or suspended by higher powers conferred by the same agency. In such cases natural selection acts so as to build up a plastic adaptable individual which, by producing the appropriate modification, can meet any of the various forces to which it is likely to be exposed; and this, it is claimed, is in many instances more valuable than the more perfect, but more rigid, adjustment of inherent variations to a fixed set of conditions.

"If this view of individual adaptability, as due to natural selection, be not accepted, it may be supposed that the individual modifications are due either to the direct action of the external forces or to the internal tendencies of the organism. But it is impossible to understand how the mechanical operation of such forces as pressure, friction, stress, etc., continued through a lifetime, could evoke useful responses, or why the response should just attain and then be arrested at a level of maximum efficiency. The other supposition—that organisms are so constituted that they *must* react under external stimuli by the production of new useful characters, or the useful modification of old ones, closely resembles the old idea of an 'innate tendency towards perfection' as the motive cause of evolution—a conception not much more satisfactory than that of special creation itself. The inadequacy of these views is clearly shown when we consider that the external forces which awake response in an organism generally belong to its inorganic (physical or chemical) environment, while the usefulness of the response has relation to its organic environment (enemies, prey, etc.). Thus one set of forces supplied the stimuli which evoke a response to another and very different set of forces. We can therefore accept neither of the suggestions which have been offered. Useful individual modifications are directly due neither to external forces nor to the inherent constitution of the organism.

"The only remaining hypothesis is that which we have already mentioned—the view that, whenever organisms react adaptively under external forces, they do so because of special powers accumulated by natural selection."

We thus see again that "Natural Selection" is a very plastic concept; its work necessarily is also plastic—when convenient. It is sometimes "replaced" or "suspended," but only because the same (suspended) agency amicably desires to "confer" higher powers. It "builds up" a "plastic and adaptable individual," which has the good grace to produce the "appropriate modification." Could anything be more convenient? It is all exceedingly mysterious, but nevertheless fascinating, and, what is more, the argument allows of ever more mysteries being dialectically heaped upon the same issues.

Certainly the individual modifications referred to are due to *both* the direct action of the external forces and to the internal tendencies of the organism. Professor Poulton fails to see this because he lacks a teleological rationale, which, as I have shown, can alone provide the clue to "usefulness"—the great

Darwinian stumbling-block. What Professor Poulton has to say about the old idea concerning an "innate tendency towards perfection" implies much more than the teleological rationale as I advocated it, which hardly goes beyond the fact that organisms do not live for themselves alone, but are involved in perpetual interaction with others. Whoever created the world and implanted any tendencies in anything, is quite immaterial to the scientific value of this rationale. Enough that it is based on facts and not on dogmas and speculations, nor on unverifiable generalisations too vast to have a sound value.

The discrepancy which Professor Poulton beholds between cause and effect in environmental forces and inner response is wholly imaginary and based on misconception. I have shown of nutrition, for instance, that cumulatively at least it certainly affects an organism, and still more a species, profoundly and in all relations.[1] The true relation of response and environment in the matter of "usefulness" cannot be based on narrow and local considerations, but is a teleological relation.

Regarding the "Mutation Theory," Sir W. T. Thiselton-Dyer's further criticism in *Nature* (2115, lxxxiii.) is here worth quoting: "I do not know whether to take comfort from the fact that if Darwin fares badly, Lamarck fares worse. 'Specific characters are never "acquired"; and there is no need for taking

---

[1] "Quale est alimentum, talis est chylus; qualis chylus, talis sanguis; qualis tandem sanguis, tales sunt spiritus," declared Lancisi in the seventeenth century.

"acquired characters" into consideration in the whole domain of comparative biology and the theory of descent' (pp. 130-1). That gets a troublesome question out of the way, at any rate." . . . "His own theory is based on the prolonged study of a single species of unknown and suspect history. It is, perhaps, one of the most remarkable cases in science of generalisation from a single instance, and that highly dubious.". . . "I think it is clear that what baffled de Vries was specific stability. It takes a somewhat prolonged subjection to cultural, *i.e.* changed, conditions to break this down. I have given numerous instances in these pages of extremely stable species which ultimately broke down. I have watched the process at Kew in *Primula obconica*, which now produces flowers two inches across. The process was described by Vilmorin half a century ago: 'The fixed character of the species being once broken, the desired variation will sooner or later appear' (Darwin, *Variation*, ii. p. 262). I cannot doubt, therefore, that if de Vries had had patience, every one of his hundred species would have become plastic in his hands."

This criticism seems fair and appropriate. In general terms and in the best Darwinian spirit it makes allowance for the plasticity of organisms, for the possibilities of changed metabolic conditions, and for the influences due to ancestral dynamics. In answer to the above de Vriesian statement, "that desert-plants 'endure' the desert only with difficulty," I would reply that they may yet, nevertheless, be adapted and — notwithstanding difficulties — become more so every day.

But to return to Professor Poulton. If the "principle" of "Natural Selection" is nothing else, it is at least "creative"—it partakes of the nature of divinity.

"The creative power of natural selection, due to the accumulation and combination by it (?) of small useful (in what sense?) variations, is also clearly set forth in a letter written by Darwin to Asa Gray a few days after the publication of the *Origin* on November 24, 1859: 'I had not thought of your objection to my using the term "natural selection" as an agent. I use it much as a geologist does the word denudation—for an agent, expressing the result of several combined actions. I will take care to explain, not merely by inference, what I mean by the term; for I must use it, otherwise I should incessantly have to expand it into some such (here miserably expressed) formula as the following: "The tendency to the preservation (owing to the severe struggle for life to which all organic beings at some time or generation are exposed) of any, the slightest, variation in any part, which is of the slightest use or favourable to the life of the individual which has thus varied; together with the tendency to its inheritance." Any variation, which was of no use whatever to the individual, would not be preserved by this process of "natural selection."' Natural selection, as above set forth by Darwin himself, has a great deal to do with 'the arrival' or building up of the fittest."

The first statement, like the whole argument of natural selection, is merely assuming the point which has to be proved; only by such methods was it possible for this mental concept of Darwin to play the part of a veritable *deus ex machinâ.* It is *ex hypothesi* "creative," though it may also at times wrathfully destroy. Darwin says he uses the term to signify the result of several (how many, and which?) combined actions, but what guarantee have we that this vague compounding of a rough number of (moreover, only very partially understood) factors has any scientific value—in fact any value at all?

What about the factor of nutrition alone? It was never adequately allowed for by Darwin, as I have shown. Darwin's own account of the way he compounded his "principle" is so bristling with diversified problems and incompatibilities (preservation? struggle? usefulness? inheritance?) that the very magnitude of each one of the separate problems should put us on our guard against precipitate generalisations. Only with a loose and frequently illegitimate use of factors and language alike could so vast a generalisation on so vague a basis have been bolstered up and perpetuated to the present day.

SUMMARY

The resemblance between the fates of species under man's direction and under nature is too shadowy to be made the basis of a "natural selection" theory.

Darwin was right in upholding Bacon's great maxim that

Nihil facit natura per saltum, but he failed to identify *saltus* with pathology. He was thus frequently obliged to strain his "principle" of Natural Selection, and conveniently declared it to be in suspense when it suited him.

Saltus quoad individuals certainly is not *saltus quoad* species, for the simple reason that reproduction provides many a powerful check upon pathological excrescences in individuals before they can take a prominent specific effect.

Domestication, in the majority of cases giving rise to a parasitic diathesis with new compatibilities, is no criterion of normal evolution, any more than is a trifling biological experiment which fails in the first instance to make a proper analysis of the object to be experimented upon.

The only valid test of survival is the test of health under a teleological rationale, which puts out of court "mutation" and "selection" theories alike.

"Endowment" is a result of response to the stimuli furnished by the environment, present and past, or, if it is to be limited to a definite physiological sense, a matter of health.

What happens in "scantily peopled areas," physiologically speaking and by way of response, has in each case to be separately and carefully analysed before any generalisations can be drawn to support either "mutation" or "selection theory."

The case of many animals and plants possessing the power of adjustment to wide differences of environment is an instance of "endowment" founded on response and teleological development generally. Dysteleological behaviour spells limitation precisely because it means inadequacy of response to environment.

De Vries' astounding conception of species as an arbitrary result "independent of environment" and for which "we can as yet assign no cause" is based on misconceptions concerning the importance of nutrition, and on failure to make a due analysis of ancestral dynamics. When it comes to matters of response and teleological development, the "argument" of natural selection being wholly futile, learned apologists are seen to stray into metaphorical language, shifting the ground from facts to dialectics. At the same time it becomes painfully evident that the concept of "usefulness" is the great Darwinian stumbling-block, and that in its narrow Darwinian sense it is wholly inadequate.

Sir Thiselton-Dyer's criticism confirms the contention that de Vries does not make due allowance for organic plasticity under changing metabolic conditions, nor for ancestral dynamics.

Darwin's own account of the way he compounded this "principle" is open to grave objections.

CHAPTER III

DARWIN (*continued*)

In the introduction to *Variations of Animals and Plants under Domestication*, Darwin has a few explanations apropos of his hypothesis of "Natural Selection." He tells us that: "In scientific investigations it is permitted to invent any hypothesis, and if it explains various large and independent classes of facts, it rises to the rank of a well-grounded theory."

We are given to understand, as regards domestication, that man "may be said to have been trying an experiment on a gigantic scale; and it is an experiment which nature during the long lapse of time has incessantly tried." But, as he himself explains on the following page, "We can further understand how it is that domestic races of animals and cultivated races of plants often exhibit an abnormal character, as compared with natural species; for they have been modified not for their own benefit, but for that of man."

If man has thus used and very frequently abused the animal world, there seems little ground for asserting that he has been trying an experiment. Such a suggestion must be regarded as an afterthought of modern imagination. Far less warrant is there for imputing nineteenth-century experiment-mongering to nature.

As regards the modifications produced by man, they require separate analysis in each case to determine their positive or negative value.

Darwin further tells us that in his *Origin of Species* it was "shown that all organic beings, without exception, tend to increase at so high a ratio, that no district, no station, not even the whole surface of the land or the whole ocean, would hold the progeny of a single pair after a certain number of generations. The inevitable result is an ever-recurrent Struggle for Existence. It has truly been said that all nature is at war; the strongest ultimately prevail, the weakest fail; and we well know that myriads of forms have disappeared from the face of the earth. If then organic beings in a state of nature vary even in a slight degree, owing to changes in the surrounding conditions, of which we have abundant geological evidence, or from any other cause; if, in the long course of ages, inheritable variations ever arise in any way advantageous to any being under its excessively complex and changing relations of life—and it would be a strange fact if beneficial variations did never arise, seeing how many have arisen which man has taken advantage of for his own profit or pleasure; if, then, these contingencies ever occur—and I do not see how the probability of their occurrence can be doubted—then the severe and often-recurrent struggle for existence will determine that those variations, however slight, which are favourable shall be preserved or selected, and those which are unfavourable shall be destroyed."

Here we have a crude account of evolution which so far has satisfied the majority of scientific men and many independent thinkers all the world over! It is a remarkable fact, but true! No one has hitherto thought of expanding Darwin's teachings regarding correlation of growth and interdependence of life, which would at once put a different complexion on the process of evolution. I have already stated that there are teleological checks to redundancy, and that fitness, predominance, power of increase, topographical distribution, struggle, extermination, are all alike teleologically determined. The proposition that all nature is at war is not true. On closer scrutiny it is seen that what struggle there is, is a matter of retribution resulting from dysteleological behaviour, and of elimination purporting teleological adjustment. I shall presently revert to this part of the controversy.

"This preservation," continues Darwin, "during the battle of life, of varieties which possess any advantage in structure, constitution, or instinct, I have called Natural Selection; and Mr Herbert Spencer has well expressed the same idea by the Survival of the Fittest. The term 'natural selection' is in some respects a bad one, as it seems to imply conscious choice; but this will be disregarded after a little familiarity."

An unsophisticated mind, on reading the account of the wonderful powers imputed to "Natural Selection," indeed feels constantly compelled to ask: Who is the "natural selector"? The term undoubtedly is bad, but the concept itself is still more objectionable. Unfortunately, the "familiarity" with this concept pleaded for by Darwin has resulted in the too credulous acceptance which has had the effect of stultifying healthy thought for half a century. It has bred facile acquiescence, dogmatism, and stagnation. Darwin himself says: "For brevity's sake I sometimes speak of natural selection as an intelligent power."

But brevity in this instance is hardly a fair excuse for such convenient personification. The levity of thought implied in this device has resulted in a vast amount of mischief. "Brevity" must unflinchingly be sacrificed to painstaking exactness if we wish to remain on a scientific level. Physiology, pathology, factors of response, of interdependence, and of co-operation, cannot at the present hour be passed over as briefly as in Darwin's days. They require careful and patient study, and most of the work yet remains to be done. To adhere dogmatically to Darwin's "principle," rather than begin the systematic investigation of these matters, amounts to a shirking of scientific duty.

"I have also often personified the word Nature; for I have found it difficult to avoid this ambiguity; but I mean by nature only the aggregate action and product of many natural laws,—and by laws only the ascertained sequence of events."

In other words, Darwin here pleads guilty to an occasional lapse into theological language. When he allowed, however, that the aggregate action and product of many natural laws makes up "nature," he ought to have contented himself with the preliminary task of duly investigating those various natural laws before attempting with one mighty sweep of "visualisation" to generalise as to their aggregate and final result. The pet child of his imagination can hardly be said to be legitimately born of a duly computed aggregate of things. It remains more or less a miraculous birth. Nevertheless, only a few lines further on, Darwin's genius for observation and interpretation is seen to rise to its highest point. "An animal or a plant may thus slowly become related in its structure and habits in the most intricate manner to many other animals and plants, and to the physical conditions of its home. Variations in the organisation will in some cases be aided by habit, or by the use and disuse of parts, and they will be governed by the direct action of the surrounding physical conditions and by correlation of growth." This passage contains a fair adumbration—could Darwin but have freed himself from the cumber of his "principle"—of the view I wish to advance as regards a teleological rationale supplying the explanation of what is termed "parallel evolution," as indeed of every other evolution. Habits, physiological action and reaction, correlation of growth, are, precisely, the factors needing study, their joint effects, in my view, providing the teleological significance of all biological developments. On the matter of "Parallel Evolution," R. H. Lock, in his *Variation, Heredity, and Evolution*, has an interesting passage, bearing at the same time on the issue of "Natural Selection":—"In plants a great number of fanciful resemblances between different species can be detected, and some between plants and animals, very few of which can be supposed to be of any possible utility to the species which exhibit them. They must be regarded as cases of parallel evolution, the *causes of which are quite unknown.* Such resemblances as that between the shoots of *Casuarina indica* and those of the common horse-tail, between *Saxifraga hypnoides* and certain mosses, between the horse- and the Spanish chestnut, between the seed of a pine and the fruit of an ash-tree, are so frequent in the vegetable kingdom as to be the delight of malicious examiners in elementary botany. It is impossible to believe that in such cases the resemblance is in itself of any value to either species, and few people will be found to maintain that the likeness of a bee- or spider-orchid to an insect is of any utility to either animal or plant." . . .

"But if resemblances can arise which are useless, and which, consequently, cannot be explained through natural selection, it becomes uncertain whether this principle can hold good as the true description of the origin of any sort of resemblance."

"On the principles here briefly sketched out," continues Darwin, "there is no innate or necessary tendency in each being to its own advancement in the scale of organisation. We are almost compelled to look at the specialisation or differentiation of parts or organs for different functions as the best or even sole standard of advancement; for by such division of labour each function of body and mind is better performed. And as natural selection acts exclusively through the preservation of profitable modifications of structure, and as the conditions of life in each area generally become more and more complex from the increasing number of different forms which inhabit it, and from most of these forms acquiring a more and more perfect structure, we may confidently believe that, on the whole, organisation advances."

This passage again shows a serious lack of orientation, and it strikingly indicates the limitation of the Darwinian outlook. We may pass over the denial of progressive response—difficult as it may sometimes be to establish—contained in the first sentence. But the narrow utilitarianism implied by the second sentence is already pathetic. It shows an utter absence of valid standards, although Darwin tentatively and vaguely introduces a kind of teleological proviso by at least referring specialisation and differentiation to the condition of body and mind. It remains to be seen, however, with every form of specialisation, whether or not it is conducive to bodily and mental progress.

No wonder the third sentence involves a more intricate tangle, and shows Darwin straying from an ill-considered sequence of events into the regions of imagination and belief. ("We may confidently believe"—what is far from satisfactorily established.)

Although "usefulness" and "profitableness"[1] again appear restricted to a low and local sense, Darwin yet manages to rise to a cheerful optimism which shows that the power of faith, especially if it is supported by honest seeking after truth, is not quite so negligible a quantity as some detractors would make it out to be.

> "Wer immer strebend sich bemüht
> Den können wir erloesen."

The corollary from Darwin's theory of course implies the justification of parasitism along the lines of the *post hoc ergo propter hoc* argumentation.

This comes out very strikingly in the following passage: "Nevertheless a very simple form fitted for very simple conditions of life might remain for indefinite ages unaltered and unimproved; for what would it profit an infusorial animalcule, for instance, or an intestinal worm, to become highly organised? Members of a high group might even become, and this apparently has often occurred, fitted for simpler conditions of life; and in this case natural selection would tend to simplify or degrade the organisation, for complicated mechanism for simple actions would be useless or even disadvantageous."

---

[1] The following passage from W. Bateson's *Materials for the Study of Variation* shows that the tendency at the present day is to become more circumspect as regards factors of analysis: "The students of adaptation forget that even on the strictest application of the theory of selection it is unnecessary to suppose that every part an animal has, and everything which it does, is useful and for its good. We, animals, live not only by virtue of, but also in spite of, what we are. It is obvious from inspection that any instinct or organ may be of use; the real question we have to consider, is how much use it is. To know that the presence of a certain organ may lead to the preservation of a race is useless if we cannot tell how much preservation it can effect, how many individuals it can save that would otherwise be lost; unless we know also the degree to which its presence is harmful; unless in fact we know how its presence affects the profit and loss account of the organism." Clearly the crux of the whole selective tangle hinges on the difficulty of drawing a proper line of demarcation between physiological and pathological development.

What indeed would it profit the intestinal worm to be highly organised, if "usefulness" for merely local and temporary purposes is alone to be considered? We have here an extreme case of pathological survival. Nevertheless, according to "selective" dialectics, the intestinal worm must be counted among the "fittest," for apparently the degraded organism would seem to have gained an immediate "profit" by its adaptations. Never was there more fatal pitfall.

SUMMARY

Darwin's own bald account of Natural Selection shows that his computation of the various contributory factors is too crude, and that he attached far too narrow and local a significance to "usefulness." He did not perceive the natural checks to redundancy in their true teleological setting, and, failing to adduce a legitimate teleological rationale of developments, he occasionally raised his "principle" to the rank of an "intelligent" power." Occasionally he did not scruple to personify nature; in other words, failing scientific explanations, he had recourse to theological methods.

In his account of "parallel evolution" and in his attempt to refer specialisation and differentiation to the condition of body and mind, Darwin adduces, however, an adumbration of a teleological rationale of evolution. But he could not free himself from the cumber of Malthusian prepossessions, which prevented the establishment of due standards of differentiation and of advancement.

The corollary from Darwin's theory, as it implies denial of pathological facts, also implies the justification of parasitism along lines of the *post hoc ergo propter hoc* argumentation.

CHAPTER IV

KROPOTKIN

In his *Variation of Animals and Plants* Darwin further tells us that when he visited, during the voyage of H.M.S. *Beagle*, the Galapagos Archipelago, situated in the Pacific Ocean about 500 miles from South America, he found himself "surrounded by peculiar species of birds, reptiles, and plants, existing nowhere else in the world. Yet they nearly all bore an American stamp." "Still more surprising was the fact that most of the inhabitants of each separate island in this small archipelago were specifically different, though most closely related to each other. The Archipelago, with its innumerable craters and bare streams of lava, appeared to be of recent origin; and thus I fancied myself brought near to the very act of creation. I often asked myself how these many peculiar animals and plants had been produced; the simplest answer seemed to be that the inhabitants of the several islands had descended from each other, undergoing modification in the course of their descent, and that all the inhabitants of the Archipelago were descended from those of the nearest land, namely America, whence colonists would naturally have been derived. But it long remained to me an inexplicable problem how the necessary degree of modification could have been effected, and it would have thus remained for ever, had I not studied domestic productions, and thus acquired a just idea of the power of Selection. As soon as I had fully realised this idea, I saw, on reading Malthus on Population, that Natural Selection was the inevitable result of the rapid increase of all organic beings; for I was prepared to appreciate the struggle for existence by having long studied the habits of animals."

It has already been pointed out that the resemblance between human "selection" and what happens by way of survival in nature is vague and unreliable.

Darwin's syllogism on this issue appears to run somewhat on the following lines:—

(*a*) All creation, including man, is engaged in a Malthusian struggle in which the unfit go to the wall.

(*b*) Man has selected certain types and rejected others according to his ideas of "usefulness" to him.

(*c*) Hence, rejection in nature on the one hand, and survival on the other, likewise result from a kind of "selection."

It is obvious that the syllogism is false, there being no legitimate connection between major and minor premiss, even if by themselves they were admissible as adequate statements of facts.

The syllogism might, however, more justifiably be stated in the following form :—

(*a*) All human operations are subject to macrocosmic operations and checks.

(*b*) Man is exercising a certain amount of selection.

(*c*) Hence, human selection is likely to be possessed of elements macrocosmically (teleologically) significant.

But, apart from that, it is clear from his own remarks that Darwin's mental constitution (by the way, it is no part of my present inquiry to examine the extent to which mental states are affected by physiological conditions, and to enter into the importance of the "personal equation" in biological philosophy), though massive in other respects, was unfortunately liable to be overwhelmingly impressed, or rather distressed, by "struggle," and to accept without scrutiny Malthusian doctrines.

It was thus due to a kind of mental antithesis that there arose the most disquieting dogmatism of modern times—a preposterous straining of language, a contortion and wholesale denial of obvious facts especially evident in all matters appertaining to parasitism and pathology.[1]

Thus, as an example, I have already alluded to Professor Arthur Thomson, in the *Hibbert Journal* for April 1910, deliberately and frigidly making the (paradoxical) statement—opposed to well-established facts regarding the zoological distribution of disease—that "wild animals in Nature have parasites but no diseases."

---

[1] "Fix upon the wrong 'part,' and the instability of the fabric built upon it is a foregone conclusion," rightly points out Henry Drummond.

But it is possible for an unbiassed mind to be impressed by factors other than "struggle," from which to arrive at different conclusions.

Thus P. Kropotkin, who gives a masterly account of his theory in his *Mutual Aid*, like Henry Drummond (*Ascent of Man*), is more impressed by co-operative factors than by "struggle," and sees in sacrifice the complementary central law of the evolutionary process.

To Drummond, "the Struggle for Life is the 'villain' of the piece, no more; and like the 'villain' in the play, its chief function is to react upon the other players for higher ends. There is, in point of fact, a second factor which one might venture to call the Struggle for the Life of Others, which plays an equally prominent part. Even in the early stages of development, its contribution is as real, while in the world's later progress—under the name of Altruism—it assumes a sovereignty before which the earlier Struggle sinks into insignificance."

As regards Kropotkin, he still seems to assign the second place to "Natural Selection." Like Malthus and Darwin, Kropotkin has spent a considerable period of his life travelling. In the work already referred to (p. vii.) he tells us: "Two aspects of animal life impressed me most during the journeys which I made in my youth in Eastern Siberia and Northern Manchuria.

One of them was the extreme severity of the struggle for existence which most species of animals have to carry on against an inclement Nature; the enormous destruction of life which periodically results from natural agencies; and the consequent paucity of life over the vast territory which fell under my observation. And the other was, that even in those few spots where animal life teemed in abundance, I failed to find—although I was eagerly looking for it—that bitter struggle for the means of existence, among animals belonging to the same species, which was considered by most Darwinists (though not always by Darwin himself) as the dominant characteristic of struggle for life, and the main factor of evolution."

Here then we have a definite natural necessity—consisting of the vicissitudes of climate—urged upon us. Nobody denies it, and nobody should use it to rush to generalisations. Organisms take their place in nature according to a teleological rationale[1]—they must accept the life compatible with their teleological status though it be precarious. The struggles and efforts borne by a species in course of time arise from its history and status. In other words, "struggle for existence" is a matter of teleological adjustment. It may be entirely due to pathology. The frequent destruction of life must thus likewise be viewed as a matter of teleological elimination, the total organism having become overgrown and dysteleological.

---

[1] The case of the cave vertebrates again deserves mention in this connection. It is significant that the lower types which are specially characterised by antithetic developments (sexual dimorphism) qualify pre-eminently (are the "fittest") for cave life and the "degenerative evolution" it implies. If Professor C. H. Eigenmann informs us correctly, no mammals appear to have become specially adapted for permanent cave life, though, of course, many spend a large part of their lives in such situations. They may be "twilight animals," but they still have normal eyes. The same is the case with birds, and there are also no cave reptiles, which is remarkable when we consider that many snakes and lizards are blind, and burrow underground. It is amongst the amphibia and fishes that true cave vertebrates are to be found. If we remember, moreover, that a "certain predisposition" is necessary in such adaptation, it becomes increasingly evident that the teleological status, as founded in factors of physiology and response, must largely determine the topographical position of animals.

In the place of an alleged bitter struggle for the means of existence (food), Kropotkin may be said to have witnessed a process of teleological adjustment. He says that the terrible arctic conditions under which he saw animal life struggling in Northern Asia made him "realise at an early date the overwhelming importance in nature of what Darwin described as 'the natural checks to over-multiplication,' in comparison to the struggle between individuals of the same species for the means of subsistence, which may go on here and there, to some limited extent, but never attains the importance of the former. Paucity of life, under-population—not over-population—being the distinctive feature of that immense part of the globe which we name Northern Asia, I conceived since then serious doubts—which subsequent study has only confirmed—as to the reality of that fearful competition for food and life within each species, which was an article of faith with most Darwinists, and, consequently, as to the dominant part which this sort of competition was supposed to play in the evolution of new species."

Broadly viewed, we may detect a hint in these lines at a process of teleological adjustment, both as regards stability and numbers, operating within the total zoological organism. Over-multiplication, where it exists, is morbid and dysteleological—a kind of rebellion within the total biological organism, which, sooner or later, according to laws of cause and effect, remonstrates and rejects superfluities in various ways. Unlimited growth of an organism or a species is teleologically impossible. Relative "dominance" of one species may occur in so far that in a particular locality it may be the most prominent in discharging teleological function. Mere conspicuousness in numbers and features for a time may be pathologically purchased. The integrity of the total organism, rather than local matters of sustenance and of excess, however, always remains the dominant issue.

"On the other hand, wherever I saw animal life in abundance, as, for instance, on the lakes, where scores of species and millions of individuals came together to rear their progeny; in the colonies of rodents; in the migrations of birds which took place at that time on a truly American scale along the Usuri; and especially in a migration of fallow-deer which I witnessed on the Amur, and during which scores of thousands of these intelligent animals came together from an immense territory, flying before the coming deep snow, in order to cross the Amur where it is narrowest—in all these scenes of animal life which passed before my eyes, I saw Mutual Aid and Mutual Support carried on to an extent which made me suspect in it a feature of the greatest importance for the maintenance of life, the preservation of each species, and its further evolution."

"And finally, I saw among the semi-wild cattle and horses in Transbaikalia, among the wild ruminants everywhere, the squirrels, and so on, that when animals have to struggle against scarcity of food, in consequence of one of the above-mentioned causes, the whole of that portion of the species which is affected by the calamity comes out of the ordeal so much impoverished in vigour and health, that *no progressive evolution of the species can be based upon such periods of keen competition.*"

The author here states that the struggle for food comes in most markedly at the culmination point of teleological adjustment, and, of course, the scramble must be the more pronounced the more exaggerated the parasitic diathesis. One may compare the calamity to the crisis in human disease—foolishly believed to have been "visited" suddenly upon a poor sufferer, when in reality it only represents the teleological reaction after years of transgression.

Of mutual aid Kropotkin says: "It is a feeling infinitely wider than love or personal sympathy—an instinct that has been slowly developed among animals and men in the course of an extremely long evolution, and which has taught animals and men alike the force they can borrow from the practice of mutual aid and support, and the joys they can find in social life." "But it is not love and not even sympathy upon which Society is based in mankind. It is the conscience—

be it only at the stage of an instinct—of human solidarity. It is the unconscious recognition of the force that is borrowed by each man from the practice of mutual aid; of the close dependency of every one's happiness upon the happiness of all; and of the sense of justice, or equity, which brings the individual to consider the rights of every other individual as equal to his own." "It was necessary to indicate the overwhelming importance which sociable habits play in Nature and in the progressive evolution of both the animal species and human beings; to prove that they secure to animals a better protection from their enemies, very often facilities for getting food (winter provisions, migrations, etc.), longevity, and therefore a greater facility for the development of intellectual faculties."

As regards the origin of Darwin's concept he tells us: "While he himself was chiefly using the term in its narrow sense for his own special purpose, he warned his followers against committing the error (which he seems once to have committed himself) of overrating its narrow meaning. In *The Descent of Man* he gave some powerful pages to illustrate its proper, wide sense. He pointed out how, in numberless animal societies, the struggle between separate individuals for the means of existence disappears, how struggle is replaced by co-operation, and how that substitution results in the development of intellectual and moral faculties which secure to the species the best conditions for survival. He intimated that in such cases the fittest are not the physically strongest, nor the cunningest, but those who learn to combine so as mutually to support each other, strong and weak alike, for the welfare of the community. 'Those communities,' he wrote, 'which included the greatest number of the most sympathetic members would flourish best, and rear the greatest number of offspring' (2nd edit., p. 163). The term, which originated from the narrow Malthusian conception of competition between each and all, thus lost its narrowness in the mind of one who knew Nature."

The question, "Who are the fittest?" is thus answered by Darwin himself in his best form by the reply: The most sympathetic, which I would more rationally call the most teleological. Apart from this expansion of Darwin's view, I cannot do better than quote *in extenso* Kropotkin's fair and apposite criticism: "Unhappily these remarks, which might have become the basis of most fruitful researches, were overshadowed by the masses of facts gathered for the purpose of illustrating the consequences of a real competition for life. Besides, Darwin never attempted to submit to a closer investigation the relative importance of the two aspects under which the struggle for existence appears in the animal world; he never wrote the work he proposed to write upon the natural checks to over-multiplication, although that work would have been the crucial test for appreciating the real purport of individual struggle. Nay, on the very pages just mentioned, amidst data disproving the narrow Malthusian conception of struggle, the old Malthusian leaven reappeared—namely, in Darwin's remarks as to the alleged inconveniences of maintaining the 'weak in mind and body' in our civilised societies (ch. v.). As if thousands of weak-bodied and infirm poets, scientists, inventors, and reformers, together with other thousands of so-called 'fools' and 'weak-minded enthusiasts,' were not the most precious weapons used by humanity in its struggle for existence by intellectual and moral arms, which Darwin himself emphasised in those same chapters of the *Descent of Man.*

"It happened with Darwin's theory as it always happens with theories having any bearing upon human relations. Instead of widening it according to his own hints, his followers narrowed it still more. And while Herbert Spencer, starting on independent but closely allied lines, attempted to widen the inquiry into that great question, 'Who are the fittest?' especially in the appendix to the third edition of the *Data of Ethics*, the numberless followers of Darwin reduced the notion of struggle for existence to its narrowest limits. They came to conceive the animal world as a world of perpetual struggle among half-starved individuals, thirsting for one another's blood. They made modern literature resound with the war-cry of woe to the vanquished, as if it were the last word of modern biology. They raised the 'pitiless' struggle for personal advantages to the height of a biological principle which man must submit to as well, under the menace of otherwise succumbing in a world based upon mutual extermination. Leaving aside the economists who know of natural science but a few words borrowed from second-hand vulgarisers, we must recognise that even the most authorised exponents of Darwin's views did their best to maintain those false ideas. In fact, if we take Huxley, who certainly is considered as one of the ablest exponents of the theory of evolution, were we not taught by him, in a paper on the 'Struggle for Existence and its Bearing upon Man,' that,

> 'From the point of view of the moralist, the animal world is on about the same level as a gladiators' show. The creatures are fairly well treated, and set to fight; whereby the strongest, the swiftest, and the cunningest live to fight another day. The spectator has no need to turn his thumb down, as no quarter is given.'

Or, further down in the same article, did he not tell us that, as among animals, so among primitive men,

> 'The weakest and stupidest went to the wall, while the toughest and shrewdest, those who were best fitted to cope with their circumstances, but not the best in another way, survived. Life was a continuous free fight, and beyond the limited and temporary relations of the family, the Hobbesian war of each against all was the normal state of existence'?"

Thus Darwin's work, in the opinion of Kropotkin, if it had been properly pursued, would have enlightened us as to the rationale of the various aspects under which "struggle" is observed, its purport, as well as about the rationale of over-multiplication.

"If we resort to an indirect test, and ask Nature: 'Who are the fittest: those who are continually at war with each other, or those who support one another?' we at once see that those animals which acquire habits of mutual aid are undoubtedly the fittest. They have more chances to survive, and they attain, in their respective classes, the highest development of intelligence and bodily organisation. If the numberless facts which can be brought forward to support this view are taken into account, we may safely say that mutual aid is as much a law of animal life as mutual struggle, but that, as a factor of evolution, it most probably has a far greater importance, inasmuch as it favours the development of such habits and characters as insure the maintenance and further development of the species, together with the greatest amount of welfare and enjoyment of life for the individual, with the least waste of energy."

A little further on we are told that Syevertsoff, "whose work is well known to ornithologists and geographers, . . . mentioned some of the species of falcons which have 'an almost ideal organisation for robbery,' and nevertheless are in decay, while other species of falcons, which practise mutual help, do thrive."

It is not difficult to perceive that all these passages emphasise the dysteleological value of the predaceous life.

I have throughout attached great importance to the physiological foundation of life and its teleological significance, and it becomes necessary now to emphasise again the surpassing importance of the metabolic basis.

Whether in the course of evolution a hypothetical entity of "Natural Selection" has "worked" or not, one factor must be conceded by all, namely, that nutrition has "worked." It has "worked," as I am throughout trying to show, universally, at all times, and with tremendous cumulative force; and further, it has always been closely associated with propagation. The importance of the physiological foundation of life, however, seems of late to have impressed itself more upon Kropotkin.

In the *Nineteenth Century* for January 1910 he re-examines Darwinism from the point of view of mutual aid and in the light of recent science. He gives a fair presentment of the Darwinian "working hypothesis," and tells us that it had a great advantage. "It explained the wonderful adaptations of animals and plants to their surroundings, which had always been a puzzle for all observers of Nature, and it was free at the same time both from a supernatural, teleological intervention, and from all metaphysics."

We have seen, however, that such claims concerning the value of Natural Selection cannot be substantiated, and that the explanation of adaptations given with the aid of this formula is frequently glaringly inadequate. Even its freedom from teleology and metaphysics, were it a fact, could not compensate for its shortcoming in being based on too narrow a concept of "usefulness." In so far as it is true that "the hypothesis of natural selection permitted the explorers, whom it invited to enter a new field of research, to study and to group the facts, and thus to discover those other natural causes besides the natural selection of chance variations, which might also give the same wonderful adaptations of organic forms to an infinite variety of surroundings," we will readily concede, however, that it has at least been of great stimulative and historical value. But this is more justly pleaded of Darwin's direct example of study.

The irony of the matter is that, in the absence of sufficiently wide (cosmic or teleological) concepts regarding the most important factors of evolution, Darwin's disciples are as apt to become as dogmatic on the point of "Natural Selection" as believers in the supernatural frequently do. "*Chassez les préjugés par la porte, ils reviendront par la fenêtre.*" Darwin already was surprised at Huxley's rating "higher than I do the necessity of Natural Selection being shown to be a *vera causa* always in action." In a footnote, we are at this stage of Kropotkin's article introduced to a remark of A. R. Wallace's, that at the outset "no discrimination was made between 'natural preservation,' which is the true domain of natural selection, and 'selection' properly speaking. A great deal of confusion resulted therefrom."

But this helps us very little, for, as I have shown, "preservation" *per se* is no criterion of genuine survival. "Creation or Modification," we learn—"that was for Darwin the main point. 'I only mean change of species by descent. That seems to me the turning-point,' he wrote to his friend Asa Gray even so late as May 1863. 'Personally, of course, I care much about Natural Selection; but that seems to me utterly unimportant compared to the question of Creation or Modification' (*Life and Letters*, ii. 371). 'Indeed, I have never hinted,' he wrote to Hooker in 1860, 'that Natural Selection is the efficient cause to the exclusion of the other—*i.e.* variability from climate, etc.'"

Kropotkin here further explains that by "climate" Darwin understands, in this and many other letters, the sum of external physical conditions. Darwin, we see from the above passage, left the matter of physiological causes open for further study. The more the effectiveness of physiological causes was brought home to him, the more was he willing to make concessions on the point of Natural Selection.

The following passage, in my opinion at any rate, shows the possibility of reconciling Lamarckism with Darwinism along the lines of a teleological rationale of usefulness, as I am endeavouring to establish it. "Heaven forfend me," Darwin wrote to Hooker in the already mentioned letter, "from Lamarck's nonsense of a 'tendency to progression,' 'adaptations from the slow willing of animals,' etc. But the conclusions I am led to are not widely different from his; though the means of change are wholly so" (*Life and Letters*, ii. 40).

We are further told: "Darwin knew perfectly well that Natural Selection was only an hypothesis, and that to be accepted as a theory it required two tests: its capacity of explaining a vast number of facts, including the difficult cases, and some proof to show that the processes it appealed to are really going on in Nature. And when one studies his work and letters, one is really struck by the infinite pains he took to test the value of Natural Selection as an hypothesis capable of explaining the greatest imaginable variety of biological facts and the most complex problems offered by evolution.

"As to the second of the tests to which an hypothesis has to be submitted—the extent of the processes it appeals to—Darwin apparently left it to the study he was going to make of Struggle for Life and Natural Selection in his great work on *Variation in the State of Nature*. This is probably why, in the *Origin of Species*, he gave as proofs of an acute Malthusian struggle only the arithmetical argument of *possible*—not actual—increase of animals, the fact of rapid increase of European species imported into other countries, and a paragraph of a few lines only containing a few indirect proofs, some of which appear now to be open to a different interpretation. He mentioned in the *Origin* (p. 50) the three different forms which struggle for life may take in nature, saying that 'there must be in every case a struggle for existence, either one individual with another of the same species, or with individuals of distinct species, or with the physical conditions of life' (*Origin*, p. 50); but he did not even try to discriminate between these three aspects of struggle, so widely different as to their consequences for the genesis of new species and for natural selection altogether. He left it for a future occasion."

The points here raised by Kropotkin, of a "possible" as opposed to an actual (a teleologically possible, I should say) increase of numbers and of a need of discrimination between different kinds of "struggle," are all-important. We see that their profounder consideration was thus left for future occasions.

"In the meantime Darwin's health was failing, and he frequently complained in his letters of feeling unable to deal with such a vast problem as the relative value of the different factors of evolution. Since he had broken the spell of immutability, a legion of biologists had rushed to the study of a multitude of factors involved in evolution, and the more they advanced in their studies the more complicated rose before them the interaction of these different agencies. So that Darwin, after having himself started all these researches, and vivified them by a general idea, and shown the way to deal with them, had to leave them to his followers."

It is interesting to learn further that "from Darwin's note-books we see that in 1837, before he had read (in October 1838) Malthus's *Essay on Population*, he explained the appearance of a new species chiefly by adaptation to changing circumstances. Even in 1844, after he had read the *Essay* of Malthus, he continued to give prominence to the direct action of surroundings.

But later on his opinions changed, and by the end of 1856 he already wrote to Hooker that, after having studied variation under domestication, he came to the conclusion that 'external conditions (to which naturalists so often appeal) do by themselves *very little*.' He added, however: 'How much they do is the point of all others on which I feel myself very weak. I judge from the facts of variation under domestication, and I may yet get more light.'"

All this perplexity again justifies my remarks as regards an urgent need of proper analytical methods in biology, with which to make an adequate computation of ancestral dynamics, and of nutritional effects. In 1862, we are told, a change began to take place in Darwin's mind. "Amidst occasional remarks about the progress of his work on Variation among the domesticated animals and plants, he dropped the following confession: 'I hardly know why I am a little sorry, but my present work is leading me to believe rather more in the direct action of physical conditions. I presume I regret it because it lessens the glory of Natural Selection, and it is so confoundedly doubtful. Perhaps I shall change again, when I get all my facts under one point of view, and a pretty hard job that will be.'

"From a letter to Mr Horace Dobell, written in February 1863, we see that his hesitations continued. In his lectures 'On the Germs and Vestiges of Disease,' Mr Dobell spoke of variations in the quantity of force exhibited by an organism in the operations of life (very near, by the way, to the accommodation 'effort' of Lamarck), and Darwin agreed with him that 'the conditions of life must play a most important part in allowing this quantity of increase.' But how far these conditions act on the *forms* of organic life he could not see clearly.

"'In fact'—he added (I italicise some passages)—'no part of my subject has so completely puzzled me as to determine what effect to attribute to (what I vaguely call) *the direct action of the conditions of life. I shall before long come to this subject*, and must endeavour to come to some conclusion when I have got the mass of collected facts in some order in my mind. *My present impression is that I have underrated this action in the Origin.*'—*More Letters*, i. 235.

"It is evident that at that time Darwin was perplexed how to determine the part which belonged to Natural Selection and that which belonged to the Direct Action of the Surroundings—the 'mistress' and the 'handmaid.' He apparently realised sometimes that the handmaid who produced the variations could submit to Natural Selection variations so useful that little choice was left for the approval of 'the mistress.' Could not new species, better appropriated to new conditions, be produced in the same way as the function produces the organ—as had been indicated by Herbert Spencer? But at other times Darwin and his friends must have asked themselves, Why are there no direct proofs of the action of surroundings being capable of producing a *permanent* variety, and still less a new species? Why has not even some simple organ, harmonised with the whole of the structure, ever been produced experimentally by altering the conditions of growth of a plant, or of life for an animal?"

"Experimental morphology, such as it exists now, did not exist forty years ago; and instead of speculating, as Lamarck did in 1809, and Spencer in 1852, about the ways in which new functions *could* modify a group of muscles or an organ, he preferred to keep to the then safer ground of Natural Selection."

These admissions practically give the whole case of Natural Selection away, although to what extent Darwin did underrate "the direct action of the conditions of life" only becomes apparent on a due consideration of nutritional influences. The latter part of the passage is especially interesting as illustrating again to what astounding allegorical and metaphysical language recourse has to be had, failing a due demarcation between physiological and pathological development. Even the new science of experimental morphology, to which Kropotkin rightly refers as easily calculated to upset Darwin's theory, will, however, avail us little unless based on a proper analysis.

"In 1868 Darwin distinguished already two different parts in the process of adaptation. The surroundings, by their direct action upon the plant, produce the beginnings of *adapted* organs—elementary spines and thorns, due to the abortion of the lobes of the leaves. Variation, in this case, is no longer a *chance* variation.

It is directed in the proper, necessary way: it is an adaptation. Speaking metaphorically, it is no longer purposeless, because it is the dry atmosphere which diminishes the evaporating surface of the leaves, maintaining only their veins transformed into elementary spines or thorns. The 'handmaid' offers to Natural Selection something which the 'mistress' dare not reject. It is Natural Selection which becomes a handmaid to direct action."

Thus "chance" goes overboard, and the rôles of mistresses and handmaids are being reversed. It is now only meet, in this democratic age, that "handmaids" and "mistresses" should likewise go.

Given the great plasticity of organic beings, every response in the direction of greater stability means an enhancement of teleological status. Such enhancement having being achieved by an organism, it subsequently proceeds, in various ways, to eliminate relatively dysteleological elements—those which the mistress "daringly" rejects (rejection in respect of teleological necessities). With retrogressive adaptations, of course, the rôle of elimination becomes still more pronounced.

Kropotkin, however, mainly concerned with emphasising the importance of mutual aid in evolution, has not attained to a valid teleological argument, and is yet too firmly in bondage to conventional ideas. His criticism therefore mainly runs on special lines. He continues thus: "Nor is the above variation an 'individual variation.' If there is in the surroundings a cause — the dryness of the atmosphere — which produces an abortion of the lobes of the leaves, it acts upon all the individuals of the same locality. It is a *group variation*, and the sharpest struggle for life goes on no longer between the individuals of the same group, but between the group and its competitors from other species. Natural Selection eliminates with preference the individuals of other species which cannot undergo the same useful transformation—those which are more refractory to the action of a dry environment and retain broad leaves. Impressionability, plasticity, become the subject of struggle."

Again, I would here draw the vital inference that elements which are pathological, or relatively dysteleological (impediments and units incapable of response), require elimination—singly or in wholesale fashion, as the case may be.

Biological, physiological, and geographical "isolation," according to Kropotkin, are now all and sundry recognised as factors of evolution. But it must be added that the isolation most to be dreaded is that isolation which spells incompatibility with the teleological status of the race because of dysteleological habits.

We might profitably pause for a moment to examine Kropotkin's consideration of "biological" and "physiological isolation." He tells us that, "however—and this is what interests us most from our special point of view—the necessity of a bitter struggle for life inside the species, for the origin of new species, vanishes more and more. This struggle is simply avoided. Over-multiplication is prevented by portions of the species taking to new grounds, or to different sorts of food, or to different modes of life. Countless examples of such a colonisation are found with all sociable animals. With the ants they are especially striking, colonisation undoubtedly contributing very much to maintain the immense extension of the different species of ants. And the results of such a colonisation are invariably to avoid that individual Malthusian struggle which arithmetical calculations may have led us to assume."

Again, we can easily perceive that nutritional factors, as they are mainly responsible for morphological development, must likewise play a vast rôle in determining racial developments, and that "dominance" in a species is founded on legitimate metabolic conditions, which alone can conduce to harmonious teleological adaptation. Kropotkin merely states the fact that frequently the "struggle" is avoided, but only too slightly adumbrates the true inwardness of the alleviation as founded in teleological adjustment. It has already been pointed out that animals, so long as they abstain from depredation and infeeding, rather than developing fastidiousness, can exist upon a vast variety of sustaining food. Whether or not animals can retain choice of new grounds and of new modes of life likewise must largely depend on the state of their nutritional conditions.

Not every type of animal can adjust itself to changes of food as readily as the squirrel, for instance. In many cases a disharmonious nutritional adaptation has produced a severe fastidiousness inhibiting the power of adjustment to new modes of life. Every habitual intensification of infeeding—as it is directly responsible for limitation and curtailment of life, and *pari passu* for bitter "struggles"—is tantamount to a fatal physiological and biological "isolation"—isolation to be followed by separation and elimination and, as the case may be, by extermination. It was thus that, the whole species of giant armadillo having been destroyed by the sabre-toothed tiger, the latter's teeth-formation rendered it impossible for him to prey on any other animal. The sabre-toothed tiger thus found himself in pronounced and fatal physiological isolation, which is only one of the many startling symptoms of retribution arising from a dysteleological life. In similar fashion we must assume individual animals frequently isolating themselves from their race (ceasing to remain gregarious), subsequently to fall an easier prey to predaceous types.

As regards the possibilities of sociable animals, colonisation *per se* does not yet necessarily imply legitimate metabolic ratios. It may, however, imply that the good effects of an erstwhile beneficent social organisation, notwithstanding later transgressions, persist for a considerable period and render recoveries possible, if only by virtue of the very efforts (use of faculties) entailed in the work of colonisation.

In the last paragraph of his suggestive article

Kropotkin quotes the following passages from Darwin's later correspondence, which speak for themselves :—

"'In my opinion,' he wrote, 'the greatest error I have committed has been not allowing sufficient weight to the direct action of environment, *i.e.* food, climate, etc., independently of Natural Selection. Modifications thus caused, which are neither of advantage nor disadvantage to the modified organism, would be specially favoured, as I can now see, chiefly through your observations, by isolation in a small area, where only a few individuals lived under nearly uniform conditions. When I wrote the *Origin*, and some years afterwards, I could find little good evidence of the direct action of environment; now there is a large body of evidence, and your case of *Saturnia* is one of the most remarkable of which I have heard.' (*Life and Letters*, iii. 159.)

"And in March 1877, writing to the Vienna Professor Neumayr about the work of Mr Hyatt on extinct Cephalopods in America, he expressed himself in nearly the same words. 'There can be no doubt,' he wrote, 'that species may become greatly modified through the direct action of environment. I have some excuse,' he added, 'for not having formerly insisted more strongly on this head in my *Origin of Species*, as most of the best facts have been observed since its publication.'"

"As regards the sense Darwin attributed to the word 'chance,' he warned his readers against a possible misunderstanding. In using this word he simply wanted to emphasise that nature shows no evidence of evolution being in accordance with a 'preconceived aim,' or being governed by a 'guiding power.' The multitude of variations which appear in every generation of plants and animals without any preconceived plan, as a consequence of the multitude of forces acting in all possible directions, is quite sufficient, he maintained, for producing all the wonderful adaptations of organic beings to their surroundings, once there is struggle for life and Natural Selection. But he certainly never forgot that every fact in nature is a necessary consequence of the so-called laws of nature. Therefore he reminded his readers that when he spoke of 'chance variations' he simply meant variations the causes of which were unknown."

The moment we are able to indicate the causes of variation—mainly consisting, in my opinion, in metabolic fluctuations—"chance" has to go by the board, and a proper sequence of events can take its place.

Kropotkin concludes: "Darwin himself was forced to recognise that when the conditions of life are altered, the change of habits not only increases variability by acting somehow upon the genetic processes: it produces also variation in a definite direction; and in many cases the variations are adaptations. How does it produce them? We don't know yet, and it would require a special physiological investigation in each separate case to explain it; but the fact is there, and we must recognise it."

"To be cumulative in its effects, there must be, beside the chance variations, a cause, such as hybridism, or still more so the direct action of the environment, which tends to alter the structure and the forms of the animal or the plant in a certain definite direction. This is the result of all these researches. But once there is such a cause, there is no need of an acute struggle between the individuals of the species to preserve the effects of variation. The acting cause will itself accumulate them, and increase them in the subsequent generations. The hypothesis which saw in the struggle for life the cause of accumulated variation is no longer necessary, once we have in the direct action of environment a real cause producing the same effects."

This is the identical logical position for which I am contending. As regards the "cumulative effects" producing variations here alluded to, I attribute their definite and ascertainable causes mainly to nutritional factors. It is the latter that deserve the fullest physiological investigation on the lines of a rational analysis, as I am throughout endeavouring to show.

Before passing on to a consideration of Malthus's work, the following passages from Kropotkin's *Mutual Aid* are specially worth quoting, as illuminating many points I have made concerning teleological behaviour, teleological status, and as bearing on the rise of sociability.

"In that immense division of the animal kingdom which embodies more than one thousand species, and is so numerous that the Brazilians pretend that Brazil belongs to the ants, not to men, competition amidst the members of the same nest, or the colony of nests, does not exist. However terrible the wars between different species, and whatever the atrocities committed at war-time, mutual aid within the community, self-devotion grown into a habit, and very often self-sacrifice for the common welfare, are the rule. The ants and termites have renounced the 'Hobbesian war,' and they are the better for it. Their wonderful nests, their buildings, superior in relative size to those of man; their paved roads and overground vaulted galleries; their spacious halls and granaries; their corn-fields, harvesting and 'malting' of grain; their rational methods of nursing their larvæ, and of building special nests for rearing the aphides, whom Linnæus so picturesquely described as 'the cows of the ants'; and, finally, their courage, pluck, and superior intelligence—all these are the natural outcome of the mutual aid which they practise at every stage of their busy and laborious lives. That mode of life also necessarily resulted in the development of another essential feature of the life of ants: the immense development of individual initiative, which, in its turn, evidently led to the development of that high and varied intelligence which cannot but strike the human observer."

"In fact, the ant thrives without having any of the 'protective' features which cannot be dispensed with by animals living an isolated life. Its colour renders it conspicuous to its enemies, and the lofty nests of many species are conspicuous in the meadows and forests. It is not protected by a hard carapace, and its stinging apparatus, however dangerous when hundreds of stings are plunged into the flesh of an animal, is not of a great value for individual defence; while the eggs and larvæ of the ants are a dainty for a great number of the inhabitants of the forests. And yet the ants, in their thousands, are not much destroyed by the birds, not even by the ant-eaters, and they are dreaded by most stronger insects."

"The sociability of the bees is the more instructive, as predatory instincts and laziness continue to exist among the bees as well, and reappear each time that their growth is favoured by some circumstances. It is well known that there always are a number of bees which prefer a life of robbery to the laborious life of a worker; and that both periods of scarcity and periods of an unusually rich supply of food lead to an increase of the robbing class."

"It may also be added that the rarity of associations larger than that of the family among the carnivores and the birds of prey, though mostly being the result of their very modes of feeding, can also be explained to some extent as a consequence of the change produced in the animal world by the rapid increase of mankind. At any rate it is worthy of note that there are species living a quite isolated life in densely inhabited regions, while the same species, or their nearest congeners, are gregarious in uninhabited regions. Wolves, foxes, and several birds of prey may be quoted as instances in point."

Is it not all rather a case of the dysteleological types being everywhere obliged, in the long run at any rate, to make room for the teleological?

"The little but extremely swift lapwings (*Vanellus cristatus*) boldly attack the birds of prey. To see them attacking a buzzard, a kite, a crow, or an eagle, is one of the most amusing spectacles. One feels that they are sure of victory, and one sees the anger of the bird of prey."

"With kindred species the cranes contract real friendship, and in captivity there is no bird, save the also sociable and highly intelligent parrot, which enters into such real friendship with man. 'It sees in man, not a master, but a friend, and endeavours to manifest it,' Brehm concludes from a wide personal experience. The crane is in continual activity from early in the morning till late in the night; but it gives a few hours only in the morning to the task of searching for its food, chiefly vegetable. All the remainder of the day is given to society life. 'It picks up small pieces of wood or small stones, throws them in the air and tries to catch them; it bends its neck, opens its wings, dances, jumps, runs about, and tries to manifest by all means its good disposition of mind, and always it remains graceful and beautiful.' As it lives in society *it has almost no enemies*, and though Brehm occasionally saw one of them captured by a crocodile, he wrote that except the crocodile he knew no enemies of the crane. It eschews all of them by its proverbial prudence; and it attains, as a rule, a very old age. No wonder that for the maintenance of the species the crane need not rear a numerous offspring; it usually hatches but two eggs. As to its superior intelligence, it is sufficient to say that all observers are unanimous in recognising that its intellectual capacities remind one very much of those of man."

"The other extremely sociable bird, the parrot, stands, as known, at the very top of the whole feathered world for the development of its intelligence. Brehm has so admirably summed up the manners of life of the parrot, that I cannot do better than translate the following sentence:—

"'Except in the pairing season, they live in very numerous societies or bands. They choose a place in the forest to stay there, and thence they start every morning for their hunting expeditions. The members of each band remain faithfully attached to each other, and they share in common good or bad luck. All together they repair in the morning to a field, or to a garden, or to a tree, *to feed upon fruits.* They post sentries to keep watch over the safety of the whole band, and are attentive to their warnings. In case of danger, all take to flight, mutually supporting each other, and all simultaneously return to their resting-place. In a word, they always live closely united.'

"They enjoy the society of other birds as well."

Here we have striking examples of absence of "enmity" combined with longevity (non-acceleration), sagacity, sociability—based on what? On legitimate feeding.

The grey parrot has also been described as the "bird-man."

"Very few birds of prey or mammals dare attack any but the smaller species of parrots, and Brehm is absolutely right in saying of the parrots, as he also says of the cranes and the sociable monkeys, that they hardly have any enemies besides men." Such facts deserve the greatest emphasis.

"In the face of an exuberant life, the ideally-armed (?) robber must be satisfied with the *off-fall* of that life."

"Going now over to mammals, the first thing which strikes us is the overwhelming numerical predominance of social species over those few carnivores which do not associate.

"How trifling, in comparison with them, are the numbers of the carnivores! And how false, therefore, is the view of those who speak of the animal world as if nothing were to be seen in it but lions and hyænas plunging their bleeding teeth into the flesh of their victims! One might as well imagine that the whole of human life is nothing but a succession of war massacres."

"As to the intellectual faculty, while every Darwinist will agree with Darwin that it is the most powerful arm in the struggle for life, and the most powerful factor of further evolution, he also will admit that intelligence is an eminently social faculty. Language, imitation, and accumulated experience are so many elements of growing intelligence of which the unsociable animal is deprived. Therefore we find, at the top of each class of animals, the ants, the parrots, and the monkeys, all combining the greatest sociability with the highest development of intelligence. The fittest are thus the most sociable animals, and sociability appears as the chief factor of evolution, both directly, by securing the well-being of the species while diminishing the waste of energy, and indirectly, by favouring the growth of intelligence."

All that remains to be added is that only a teleological nutrition, with a consequent absence of reproductive vicissitudes, can guarantee the possibilities of education.

"We have any number of direct observations of the peace that prevails in the nesting associations of birds, the villages of the rodents, and the herds of grass-eaters; while, on the other side, we know of few sociable animals which so continually quarrel as the rats in our cellars do, or as the morses, which fight for the possession of a sunny place on the shore.

"No one will deny that there is, within each species, a certain amount of real competition for food—at least, at certain periods. But the question is, whether competition is carried on to the extent admitted by Darwin, or even by Wallace; and whether this competition has played, in the evolution of the animal kingdom, the part assigned to it.

"One species succumbs, not because it is exterminated or starved out by the other species, but because it does not well accommodate itself to new conditions, while the other does.

"However, an attentive reading ot the different chapters in which Darwin and Wallace speak of this subject soon brings one to the conclusion that the word 'extermination' does not mean real extermination; the same remark which Darwin made concerning his expression, 'struggle for existence,' evidently applies to the word 'extermination' as well. It can by no means be understood in its direct sense, but must be taken 'in its metaphoric sense.'"

Here, again, the evidence supports my view regarding the real significance of the "struggle for existence," and I think it can be fairly claimed for my explanations that they reasonably account for many Darwinian perplexities.

SUMMARY

Kropotkin assigns to the selfish struggle for existence the place of second only to his principle of mutual aid. The impressions that he gathered from his travels and observations were calculated to support the view that a teleological rationale determines the vicissitudes and the place in nature of a particular species, and that "struggle for existence" is mainly a matter of pathology and of teleological adjustment.

He failed to see the evidence for the bitter struggle for the means of existence as postulated by Darwin and his school.

Paucity of life, under-population—not over-population—according to him, is the distinctive feature of immense parts of the globe.

Over-population must be viewed as a dysteleological development—a kind of rebellion within the total biological organism, demanding more or less speedy adjustment. Unlimited growth of an organism or a species is teleologically impossible. "Dominance" hinges on discharge of teleological function. Transitory conspicuousness of numbers and features (a deceptive "dominance") may be pathologically purchased. The integrity of the total zoological organism, rather than local matters of sustenance and of excess, always remains the dominant issue. The struggle for food only comes in at the culmination point of teleological adjustment. Solidarity—the unconscious recognition of the force that is borrowed by each organism from the practice of mutual aid—is the keynote of Kropotkin's theory.

Kropotkin states that Darwin himself was at times inclined to think that it was on the whole "the most sympathetic" which survived, and he hints that such a view might have become the basis of most fruitful researches. He shows that those animals which acquire habits of mutual aid are generally apt to survive those in which sociability is less marked. It is, however, necessary to add that a proper metabolic foundation of life is the prerequisite of such beneficent development.

The importance of physiological conditions has latterly impressed itself upon Kropotkin (*Nineteenth Century*, January 1910). In Darwin's day physiology was not sufficiently advanced, and Darwin sagaciously hinted that further study might easily tend towards modifications of his theory. He did not wish to establish dogmas. That was left for his vulgarisers to perform.

In 1862 a change began to take place in Darwin's mind, and he practically admitted being much puzzled over the problem of making a due demarcation between physiological and pathological development. The more he considered "the direct action of physical conditions," the more this seemed to lessen the glory of "Natural Selection."

In 1868 we find Darwin still further advanced in his search for sequence of events among physiological causes.

Kropotkin, though he shows that new conceptions must creep in, totally modifying the struggle for life so as to deprive it of its bitter individualist character, cannot yet quite rid himself of "Natural Selection." He emphasises biological and physiological "isolation," but fails to see their teleological significance. Whether animals can profitably take up new grounds and new modes of life primarily depends on their nutritional habits. The extinction of the sabre-toothed tiger presents an instance of retribution through physiological and biological isolation befalling all predaceous types.

Colonisation *per se* does not necessarily imply legitimate metabolic ratios. It may imply that the good effects of an erstwhile beneficent social organisation—though now deviated from—still persist with possibilities of recovery by virtue of the very efforts entailed by the work of colonisation.

In a letter to Moritz Wagner, Darwin frankly admits having underrated environmental factors, more evidence having since been accumulated.

Kropotkin concludes his consideration of Darwin's correspondence with the demand, with which I entirely agree, for a special physiological investigation in order to explain the various cases of variation, and he actually goes so far as to declare that "the hypothesis which saw in the struggle for life the cause of accumulated variation is no longer necessary, once we have in the direct action of environment a *real* cause producing the same effects."

CHAPTER V

MALTHUS

An inquiry such as that of Malthus into the principle of population should really begin where a well-considered Darwinism leaves off. As it stands, however, Malthus's work rests on a purely empirical basis. I have already dealt with Malthus's "arithmetical argument" from the new biological point of view, which allows for dissociation, for the time-element, and for teleological adjustment.

Malthus—to quote his own words—bases himself on "the constant tendency in all animated life to increase beyond the nourishment prepared for it." He has no conception of the operation of teleological checks, but only refers to indirect ones which he believes to be counteracting tendencies to redundancy. It is essential to know in every case to what extent this alleged "constant" tendency is normal, and to what extent abnormal and pathologically determined. How much of it, for instance, is occasioned by habitual overfeeding? We do know that domestication frequently increases "fertility," which, in my view, is due to an induced parasitic diathesis. In any case, what "tendency" there is in animal reproduction must be considered as to its biological significance, and the same must be said of the "tendency" in plant reproduction. Moreover, intimate correlations and interrelations exist between plant and animal life. The prolific nature of plant fertility, if anything, appears greater than that of animal fertility, and the multiplication of plants, according to animal needs, is largely a matter of animal volition and of cultivation.[1] So far is it from being a fact that all animal life tends to increase beyond the nourishment prepared for it, the universal institution of embryonic and infant nutrition goes to prove that increase and nourishment proceed *pari passu*, which at least lends support to the view that nutrition in general is teleologically prepared and determined. Malthus says: "It is observed by Dr Franklin, that there is no bound to the prolific nature of plants or animals, but what is made by their crowding and interfering with each other's means of subsistence. Were the face of the earth, he says, vacant of other plants, it might be gradually sowed and overspread with one kind only, as, for instance, with fennel; and were it empty of other inhabitants, it might in a few ages be replenished from one nation only, as, for instance, with Englishmen." His comment on Dr Franklin's sweeping generalisation is: "This is incontrovertibly true."

---

[1] The qualities and characteristics of fruits, plants, and trees, for instance, can be completely transformed by feeding, and almost any condition of vegetable tissue needed can be produced at will. In an excellent paper in the *Fortnightly Review* for June 1910, Sampson Morgan points out that "the sarcocarp of the apple, for instance, is living matter which grows, and the growth of this living matter can be acted upon so that when the pome is fully matured it will contain double and treble the amount of nutrients apples fed under the ordinary system possibly can. Heretofore the important part played by the sarcocarp of fruits has been completely ignored." This is a good illustration of the manner in which cultivation can increase and improve sustenance by making right use of what teleologically speaking constitutes the appropriate food energy of a species—an example of the margin of seed-production teleologically provided by the vegetable kingdom.

The contemplation of what "might" happen "if" all germs could "freely" (?) develop fills Malthus with consternation; but almost in the same breath he tells us that "Necessity, that imperious, all-pervading law of nature, restrains them within the prescribed bounds. The race of plants and the race of animals shrink under this great restrictive law; and man cannot by any efforts of reason escape from it."

But is it legitimate to speak of the "all-pervading" law of "necessity," and then proceed to identify it with a "great restrictive law." That necessity, or rather necessities, exist, I readily concede, but it is just this necessity which requires the closest investigation, before any generalisation can be come to.

He continues: "In plants and irrational animals, the view of the subject is simple. They are all impelled by a powerful instinct to the increase of their species; and this instinct is interrupted by no doubts about providing for their offspring."

However this may be, those powerful instincts are subject to equally powerful biological laws regulating reproduction. Thus, to reiterate but one, there is nature's demand for a provision of an embryonic food-supply according with the specific nutritional habits, a matter in which—as will presently be seen in greater detail—nutritional and consequent sexual transgressions are visited upon the parent according to law.

Whether or not in their propagations animals take their real necessities into account, they are nevertheless restrained by them, and in all cases of perverted instincts the restraint takes the shape of severe retribution.

"Wherever therefore there is liberty, the power of increase is exerted; and the superabundant effects are repressed afterwards by want of room and nourishment."

There is, of course, more than a semblance of truth inherent in this proposition, in so far as a dysteleological rate of increase always meets with natural checks. But Malthus omits from consideration the most important concomitant, usually present, viz. the factor of pathology. The exaggerated importance which Malthus attaches to the "want of room and nourishment" aspect is thus accounted for. It is not to the glory of Darwinism that it has since perpetuated this error, nor to the credit of modern pathology that it has not supplied the deficiency. It cannot be too strongly emphasised that the factors most urgently requiring study in this connection are the pathological factors.

Let us have Kropotkin's testimony again. He says: "But this argument does not prove it at all. We might as well take a number of villages in South-East Russia, the inhabitants of which enjoy plenty of food, but have no sanitary accommodation of any kind; and seeing that for the last eighty years the birth-rate was sixty in the thousand, while the population is now what it was eighty years ago, we might conclude that there has been a terrible competition between the inhabitants. But the truth is that from year to year the population remained stationary, for the simple reason that one-third of the new-born died before reaching their sixth month of life; one-half died within the next four years; and out of each hundred born, only seventeen or so reached the age of twenty. The new-comers went away before having grown to be competitors. It is evident that, if such is the case with men, it is still more the case with animals. In the feathered world the destruction of the eggs goes on on such a tremendous scale that eggs are the chief food of several species in the early summer; not to say a word of the storms, the inundations which destroy nests by the million in America, and the sudden changes of weather which are fatal to the young mammals. Each storm, each inundation, each visit of a rat to a bird's nest, each sudden change of temperature, takes away those competitors which appear so terrible in theory.

"As to the facts of an extremely rapid increase of horses and cattle in America, of pigs and rabbits in New Zealand, and even of wild animals imported from Europe (where their numbers are kept down by man, not by competition), they rather seem opposed to the theory of over-population. If horses and cattle could so rapidly multiply in America, it simply proves that, however numberless the buffaloes and other ruminants were at that time in the New World, its grass-eating population was far below what the prairies could maintain. If millions of intruders have found plenty of food without starving out the former population of the prairies, we must rather conclude that the Europeans found a want of grass-eaters in America, not an excess. And we have good reasons to believe that want of animal population is the natural state of things all over the world, with but a few temporary exceptions to the rule. The actual numbers of animals in a given region are determined, not by the highest feeding capacity of the region, but by what it is every year under the most favourable conditions. So that, for that reason alone, competition hardly can be a normal condition; but other causes intervene as well to cut down the animal population below even that low standard. If we take the horses and cattle which are grazing all the winter through in the steppes of Transbaikalia, we find them very lean and exhausted at the end of the winter. But they grow exhausted not because there is not enough food for all of them—the grass, buried under a thin sheet of snow, is everywhere in abundance—but because of the difficulty of getting it from beneath the snow, and this difficulty is the same for all horses alike. Besides, days of glazed frost are common in early spring, and if several such days come in succession the horses grow still more exhausted. But then comes a snow-storm, which compels the already weakened animals to remain without any food for several days, and very great numbers of them die. The losses during the spring are so severe that, if the season has been more inclement than usual, they are even not repaired by the new breeds—the more so as all horses are exhausted, and the young foals are born in a weaker condition. The numbers of horses and cattle thus always remain beneath what they otherwise might be; all the year round there is food for five or ten times as many animals, and yet their population increases extremely slowly. But as soon as the Buriate owner makes ever so small a provision of hay in the steppe, and throws it open during days of glazed frost or heavier snowfall, he immediately sees the increase of his herd. Almost all free grass-eating animals and many rodents in Asia and America being in very much the same conditions, we can safely say that their numbers are not kept down by competition; that at no time of the year they can struggle for food; and that, if they never reach anything approaching to over-population, the cause is in the climate, not in competition.

"The importance of *natural checks* to over-multiplication, and especially their bearing upon the competition hypothesis, seems never to have been taken into due account. The checks, or rather some of them, are mentioned, but their action *is seldom studied in detail.* However, if we compare the action of the natural checks with that of competition, we must recognise at once that the latter sustains no comparison whatever with the other checks. Thus, Mr Bates mentions the really astounding numbers of winged ants which are destroyed during their exodus. The dead or half-dead bodies of the *formica de fuego* (*Myrmica sævissima*) which had been blown into the river during a gale 'were heaped in a line an inch or two in height and breadth, the line continuing without interruption for miles at the edge of the water.' Myriads of ants are thus destroyed amidst a nature which might support a hundred times as many ants as are actually living. Dr Altum, a German forester, who wrote a very interesting book about animals injurious to our forests, also gives many facts showing the immense importance of natural checks. He says that a succession of gales or cold and damp weather during the exodus of the pine-moth (*Bombyx pini*) destroy it to incredible amounts, and during the spring of 1871 all these moths disappeared at once, probably killed by a succession of cold nights. Many like examples relative to various insects could be quoted from various parts of Europe. Dr Altum also mentions the bird-enemies of the pine-moth, and the immense amount of its eggs destroyed by foxes; but he adds that the parasitic fungi which periodically infest it are a far more terrible enemy than any bird, because they destroy the moth over very large areas at once. As to various species of mice (*Mus sylvaticus*, *Arvicola arvalis*, and *A. agrestis*), the same author gives a long list of their enemies, but he remarks: 'However, the most terrible enemies of mice are not other animals, but such sudden changes of weather as occur almost every year.' Alternations of frost and warm weather destroy them in numberless quantities; 'one single sudden change can reduce thousands of mice to the number of a few individuals.' On the other side, a warm winter, or a winter which gradually steps in, makes them multiply in menacing proportions, notwithstanding every enemy; such was the case in 1876 and 1877. Competition, in the case of mice, thus appears a quite trifling factor, when compared with weather. Other facts to the same effect are also given as regards squirrels."

"On the other side, the *contagious diseases* which continually visit most animal species destroy them in such numbers that the losses often cannot be repaired for many years, even with most rapidly multiplying animals. Thus, some sixty years ago, the *sousliks* suddenly disappeared in the neighbourhood of Sarepta, in South-Eastern Russia, in consequence of some epidemics; and for years no *sousliks* were seen in that neighbourhood. It took many years before they became as numerous as they formerly were." "Extermination by man on the one side, and contagious diseases on the other side, are thus the main checks which keep the species down—not competition for the means of existence, which may not exist at all."

To return now to Malthus. "It will be allowed," he goes on to maintain, "that no country has hitherto been known, where the manners were so pure and simple, and the means of subsistence so abundant, that no check whatever has existed to early marriages from the difficulty of providing for a family, and that no waste of the human species has been occasioned by vicious customs, by towns, by unhealthy occupations, or too severe labour. Consequently, in no state that we have yet known has the power of population been left to exert itself with perfect freedom."

It is necessary here to interpose that man's physiological transgressions always occasion a great "waste," generally the greater, the more ample the means of subsistence. A due computation of this "waste" puts out of court and demolishes the whole Malthusian argument regarding want of room and nourishment. The more disproportionate the distribution of wealth in a society becomes, the less enticement there will be for many to enter the matrimonial state. However true this proposition may be, to base the argument regarding "laws of population" upon it is to rest them upon a case of abnormality which must form wholly inadequate premises. "*Ex abusu non arguitur ad usum.*"

"Man," says Professor Lindsay, "has gone through many phases in the matter of his food, and it is likely that he has still in this department a journey to go."

Malthus further tells us: "In the back settlements, where the sole employment is agriculture, and vicious customs and unwholesome occupations are little known, the population has been found to double itself in fifteen years. Even this extraordinary rate of increase is probably short of the utmost power of population.

Very severe labour is requisite to clear a fresh country; such situations are not in general considered as particularly healthy; and the inhabitants are probably occasionally subject to the incursions of the Indians, which may destroy some lives, or at any rate diminish the fruits of their industry."

This again illustrates the pure empiricism of the whole Malthusian argumentation. Here we have an increase justified by teleological progress—agriculture, than which there is no more excellent medium of stimulating Darwinian "dominance" among the genus Homo (physiologically considered quite as much as sociologically).

Malthus's too superficial reference to the healthiness of such "situations," however, is as regardless of broad facts as that concerning the Indian danger is fanciful.

Only too truly has it been said that "*Plures occidit gula quam gladius.*"

So far as the Red Indians are concerned, like the formerly "dominant" buffaloes, they had to make room for a more teleologically functioning type of white humanity, an adjustment perpetually proceeding to maintain the efficiency of the human family. Kropotkin has an illuminating passage on the connection between agriculture and social improvement, well illustrating the teleological superiority of agriculture as compared with a mercenary or vagrant life. "The greatest and the most fatal error of most cities was to base their wealth upon commerce and industry, to the neglect of agriculture. They thus repeated the error which had once been committed by the cities of antique Greece, and they fell through it into the same crimes. The estrangement of so many cities from the land necessarily drew them into a policy hostile to the land, which became more and more evident in the times of Edward the Third, the French Jacqueries, the Hussite wars, and the Peasant War in Germany. On the other hand, a commercial policy involved them in distant enterprises. Colonies were founded by the Italians in the south-east, by German cities in the east, by Slavonian cities in the far north-east. Mercenary armies began to be kept for colonial wars, and soon for local defence as well. Loans were contracted to such an extent as to totally demoralise the citizens; and internal contests grew worse and worse at each election, during which the colonial politics in the interest of a few families was at stake. The division into rich and poor grew deeper, and in the sixteenth century, in each city, the royal authority found ready allies and support among the poor."

Very few more criticisms of Malthus's main position will be sufficient for our purpose.

The proviso "when unchecked," which he constantly makes as regards his "geometrical ratio," is antecedently inadmissible.

The proposition that population, "could it be supplied with food, would go on with unexhausted vigour, and the increase of one period would furnish the power of a greater increase the next, and this without any limit," is too hypothetical and too vague. In the first place, I would remark that a mere supply of food would be quite incapable of bringing about the result which Malthus supposes. The food must be the appropriate kind of food for the species, and qualitatively and quantitatively suitable.

Secondly, there is always a certain costliness in reproduction, and it is the greater, the more rapid the rate of increase, a factor which must qualify our acceptance of the "unexhausted vigour." These considerations alone are sufficient to show that the above proposition contains ample matter for profound biological and pathological study.

Malthus must be excused for not allowing for these factors in his day. He is fair enough on another page to admit that there are "extreme" cases, "such as the negroes in the West Indies, and one or two others, where population does not keep up to the level of the means of subsistence." It would have been as inconvenient from the point of view of his theory to discover that a teleological adjustment in the ratio between subsistence and population is perpetually operating, as it is at the present hour inconvenient for natural selectionists to discover that disease is the cause of extinction.

"There are many parts of the globe, indeed, hitherto uncultivated, and almost unoccupied; but the right of exterminating, or driving into a corner where they must starve, even the inhabitants of these thinly peopled regions, will be questioned in a moral view."

This is special pleading—an exploiting of the moral sense in favour of a special doctrine. For service is the law of lowly life, and service and work have always been known by righteous (teleological) men to be the best alternatives to starvation. Inability to serve, to be useful in a teleological sense, may indeed mean extermination, as we have seen; but the "Aryans" of the present day have seen fit to teach indolent natives the benefits of labour and of industry rather than exterminate them wholesale. Whilst exacting their toll of wealth, they thus on the whole raise them in teleological status.

"To exterminate the inhabitants of the greatest part of Asia and Africa is a thought that could not be admitted for a moment."

Whilst such moral rectitude is highly commendable, it is scarcely relevant to the Malthusian argument. Moreover, the task, even were it intended, might prove too big an undertaking, as impracticable as the perfervid desire on the part of one species, or one nation, to over-multiply and overrun the globe.

Let us, however, take comfort in the idea that there is still, as in Malthus's day, "a great portion of uncultivated land" even in England and Scotland, and with this happy thought let us dismiss the Malthusian nightmare concerning arithmetical and geometrical ratios once and for all.

SUMMARY

The Malthusian premise that "the constant tendency in all animated life to increase beyond the nourishment prepared for it" is an inadequate and inadmissible generalisation. It is invalidated by many biological and teleological considerations, which show that it can have reference to abnormality only.

Malthus fails to take pathology and factors of teleological adjustment into account, dealing instead with conjectures and hypotheses.

He avers the existence of a restrictive law of necessity, but in reality, by the vagueness of his statements, he dialectically restricts the proper field of inquiry, viz. the detailed investigation of the various necessities obtaining in nutrition and reproduction, which would involve a different theory of the principle of population.

It never occurs to him to examine into the legitimacy or otherwise of instincts and tendencies, but he takes every kind of instinct as normal. Failing biological and teleological orientation, he was constrained to exaggerate the "want of room and nourishment aspect." He mainly, though of course unwittingly, argues from the abuse of nutrition as to its use. The provisos which he generally makes in his propositions are hypothetical and teleologically impossible.

He cannot explain extreme cases (paucity of population), but instead, and in order to support his proposition that the force of economical circumstances nevertheless must needs produce his hypothetical ratios, he has recourse to moral "proofs."

PART II

Reproduction

"Each species appears to us as an extremely complicated structure: the whole organic world, however, seems to be the result of innumerable different combinations and permutations of *relatively few* factors."—Professor WEISMANN.

CHAPTER I

NUTRITION AND REPRODUCTION

> "Ex quovis ligno non fit Mercurius."

> "The mechanical conception of Nature well admits of being united with a teleological conception of the Universe."—Professor WEISMANN.

§ 1. Theories regarding Reproduction.
§ 2. The Fixity of Metabolic Ratios.
§ 3. Infeeding and Parasitism are responsible for Antithetic Developments generally.
§ 4. The Case of Interior Parasites.
§ 5. The Alleged Constancy of Species.
§ 6. Experiments regarding Infeeding and Reproduction.
§ 7. The Analogies of Fertilisation.
§ 8. Nutrition determining Fertilisation.

§ 1. *Theories regarding Reproduction*

ON the basis of the principles so far propounded, the old views indiscriminately regarding every appetite *per se* as normal, and every reproduction *per se* as an indication of genuine survival, can no longer be accepted. Nutrition and reproduction, rather than means of multiplication, are pre-eminently means towards the attainment of stability and progress. Their normal effect is to produce ever-increasing nobility, beauty, and serviceableness of forms.

Let us here take a concrete case, that of conjugation, as an example. In the *Evolution of Sex*, Professors Geddes and Thomson (p. 172 of revised edition), state as the view of W. H. Rolph that: "Conjugation occurs when nutrition is diminished, whether this be due to want of light, or to the lowered temperature of autumn and winter, or to a reduction of the organisms to minimal size. It is a necessity for satisfaction, a gnawing hunger, which drives the animal to engulf its neighbour, to 'isophagy.' The process of conjugation is only a special form of nutrition, which occurs on a reduction of the nutritive income, or an increase of the nutritive needs, in consequence of the above-mentioned conditions. It is an 'isophagy,' which occurs in place of 'heterophagy.' The less nutritive, and therefore smaller, hungrier, and more mobile organism we call the male—the more nutritive and usually relatively more quiescent organism, the female. Therefore too is it, that the small starving male seeks out the large well-nourished female for purposes of conjugation, to which the latter, the larger and better nourished it is, is on its own motive less inclined."

One fact here stands out clearly and prominently, viz. that there is a most intimate connection between nutrition and reproduction. Whether the process of conjugation is one of mutual digestion, and whether fertilisation, according to Eimer, is a sort of nutrition, is another matter. Such vague conjecture does not bring us appreciably nearer the understanding of the rationale of nutrition and reproduction, nor of their relations. A more philosophic and actually justifiable view would regard both nutrition and fertilisation as essentially identical phenomena of sentient union, differing in degree, not in kind.

Rolph, conveniently for his theory, here introduces psychological factors: "motives" and "necessity for satisfaction." He qualifies them, however, by—or rather mixes them up with—economical considerations of a low materialistic kind. His difficulty, of course, is the usual inability to distinguish pathology from physiology, and of regarding developments from a broader point of view.

In so far as reproduction is not directly pathologically indicated, we must view its occurrence as the assertion of the potential racial power *vis-à-vis* the individual, *i.e.* race becomes prepotent over the individual. This may be due either to the power of ancestral dynamics or to inherent maturity, *i.e.* readiness to receive enhancement combined with the teleological duty to the race by perpetuation and improvement of the stock.

Where we meet, however, with a "gnawing hunger" going beyond the bounds of the needful, we must expect the results to become inharmonious—organismal equilibrium and balance of nature having previously been upset. If psychology is to be introduced at all, it must thus be clearly stated that psychological lapse eventually produces serious economical disturbances and abnormal and iniquitous biological states. The vicissitudes of an organism thus moving down the inclined plane, however, cannot be put forward as typical of normal life.

The morphological antithesis regarding which Rolph and most of his colleagues hold such peculiar notions is typical of an abnormal and pathological state of the organism concerned. It warrants the inference that the organism's sense of proportion is distorted, that its appetites have become abnormal. This can be experimentally verified. If to a lowly type nutrition is very abundantly supplied, its balance will be disturbed, and only a diminution of surfeit will restore it to a normal condition.

There is no warrant for the above conjecture (and it is also inelegant to say) that failing this excess of nutrition the unappeased appetite for food turns towards the "engulfing" of a bloated female. It is rather that sexual developments take a nobler course as soon as the impediment of dysteleological nutrition is removed. In the present instance it must be remembered that the alternative of conjugation is fission, a lower form of propagation which proceeds apace—is indeed stimulated and maintained—by the very conditions of surfeit. With the return of saner nutritional conditions, bringing in their train a healthier balance of life, the lower form of propagation simply becomes incompatible, and the finer stirrings of sex (entailing fertilisation and manifold elements of teleological production) become operative.

§ 2. *The Fixity of Metabolic Ratios*

In *Nutrition and Evolution* I have examined the relations between animal and plant metabolism, and traced the path of metabolic degeneration, adducing its rationale and its criteria.

It was shown that a true metabolic ratio between animal and plant exists, compared with which the metabolic distinction between animal male and female sometimes made by biological writers is insignificant. Just as it is necessary sometimes to emphasise the simple fact that all the energies which are displayed by the living cell must be derived from the energies of substances in solution, so it wants remembering that the quantity of living plant-stuff consumed day by day by animals is enormous. The very existence of the animal world, including the carnivora, depends on the sustenance afforded by the plant world.

Says K. Kraepelin in his *Die Beziehungen der Tiere zu einander und zur Pflanzenwelt*: "Wie auf dem Lande, so ist auch die Vegetation des süssen und Meerwassers der Ausnutzung durch die Tierwelt ausgesetzt. Eine grosse Rolle spielen hier namentlich die einzelligen niederen Algen, die im Meere, bei dem völligen Fehlen sonstigen Pflanzenlebens auf hoher See, als die eigentliche Grundlage und Quelle der gesamten Formenmannigfaltigkeit des marinen Tierlebens zu betrachten sind. Mögen die ersten Vertilger dieser Myriaden von Diatomeen, Desmidiaceen, Peridineen, Oscillarien usw. auch mikroskopische Protozoen, Rädertierchen, Larven und vor allem Crustaceen (Copepoden, Cladoceren) sein: sie dienen wieder grösseren zur Nahrung, den Flossenfüssern, Kielfüssern, Jungfischen, Heringsarten usw., bis schliesslich, unter Einschaltung oft noch weiterer Zwischenstufen, auch der Appetit der grössten und gefrässigsten unter ihnen, der Wale und Haie, befriedigt werden kann."

(" Just as on land, so in fresh and salt water plant life is exposed to exploitation by the animal. In the oceans a leading part is played especially by the lowly unicellular algæ, which, considering the utter absence of other forms of plant life in the open sea—must be regarded as the true *fons et origo* of the whole morphological diversity of form in marine animal life. Though the first animals to devour those myriads of diatomaceæ, desmidæ, peridinæ, oscillariæ, etc., may be only microscopic protozoa, wheel-animalcules, larvæ, and chiefly crustaceæ (copepoda, cladocera), the latter in their turn serve as food to bigger animals, until with the occasional introduction of intermediate stages even the appetite of the biggest and most rapacious of marine animals, such as whales and sharks, can thus be satisfied.")

I have already alluded to Sir E. Ray Lankester's pronouncement that suffocation would be the fate of animals if the green plants could be taken away, and I have likewise pointed out that the relation between animal and plant is characterised by many reciprocities. All animal energy, development, and morphology owe their existence to, and derive their legitimacy from, those primordial cosmic arrangements, however frequently we find transgressions in the shape of in-feeding and parasitism.

Here the obvious query suggests itself, whether, indeed, to these primordial metabolic arrangements, there is inevitably attached so profound and universal a significance.

May it not be that in the course of evolution more convenient metabolic adaptations may be feasible, without upsetting the balance of nature in general and the equilibrium of a species in particular?

Seeing that the unfolding of life proceeds frequently at tremendous expense on all sides, why should nutrition alone be religiously guarded against indiscriminate and wasteful propensities, to accord with an inconveniently rigid and cast-iron cosmic ratio?

The answer is not so much a matter of conjecture as of fact. The very wastefulness so often thoughtlessly charged against nature is the result of transgressions against metabolic ratios, as will be seen more fully when we come to deal with the extreme cases of nemesis in the matter of reproduction.

Indispensable and fundamental principles of cosmic order and cosmic progress are involved in the fixity of metabolic exigencies. If a cosmic progression along the lines of least resistance were to result from the process of evolution, the evolving animal life, from a mere foster-child of the plant, had to develop a teleological position entailing reciprocal and complemental service. A law of mutual aid has thus from the beginning of things formed the foundation of harmonious adaptation and of striking progress in many directions. It is demonstrable that some kind of food-reform along the lines of increasing conformity with nature's fixed metabolic law has preceded, attended, and conditioned every step of evolution, and that every deviation towards depredation, *i.e.* parasitism, spelled a precarious adaptation, fatal when persisted in. The growing points on the tree of organic life ever tend to shift in favour of those organisms distinguished by a legitimate metabolism. It is they who possess "resultant" faculty (growing-point faculty) capable of giving rise in time to what Darwin called "dominant" races; for only from a satisfactory physiological basis is it possible to evolve anything approaching a promising social organisation.

§ 3. *Infeeding and Parasitism are responsible for Antithetic Developments generally*

I have likewise pointed out that the narrower biological principle of domestic division of labour from its very beginnings is intimately bound up with metabolic developments. I have shown that as a consequence of depredation and parasitism the principle of division of labour becomes distorted in manifold ways—domestic and reproductive—as outwardly manifested in antithetic developments. We may get pigmy males leading a parasitic existence upon the bloated females. Such monstrous cases of extreme and entirely pathological sexual dimorphism are curiously enough by many biological authorities referred to a normal and fundamental protoplasmic antithesis "due to male katabolism and female anabolism." The evidence, however, that a violation of metabolic ratios is mainly responsible for the enormous crop of pathological developments is simply overwhelming. A striking example from the embryonic sphere is presented by the yolk-glands, as they occur, for instance, in some of the lower worms (tubellarians, flukes, tapeworms), supposed to represent a degenerate portion of the ovary, in which "the cells have become even more highly nutritive than ova." In other words, these yolk-glands must be viewed as hypertrophied portions of the ovary. But the hypertrophy of the ovary is only part and parcel of the general pathology. It is the outcome of parasitism, and represents a just nemesis befalling flukes and tapeworms.

Parasitism always tends to atrophy important parts, whilst hypertrophying others, thus gradually establishing antithetic developments in life and form. For the sequel of long-continued depredation is a gradual intensification of all selfish propensities, until finally members of the same organ or community start preying anarchically (antithetically) upon adjacent members.

It is only too true, as Henry Drummond said: "The parasite not only injures itself, but wrongs others. It disobeys the fundamental law of its own being, and taxes the innocent to contribute to its own disgrace. So that if Nature is just, if Nature has an avenging hand, if she hold one vial of wrath more full and bitter than another, it shall surely be poured out upon those who are guilty of this double sin."

Significantly, as bearing on the interrelations of nutrition and sex, we are told in the *Evolution of Sex* that "the reproductive buds of some Cœlenterates become true nurseries." It shows how nature seeks to counterpoise all extremes. The problem of balancing the requirements of reproduction with the anomalies of an existing diathesis, however, is not always so simple. There are cases of a dreadful dilemma, on the point of making both ends meet, the hereditary voracity and cannibalism of certain parasitic offspring finally constituting an awful nemesis, with which we shall have to deal later.

It is already obvious, however, that a pronounced parental parasitism—always the main cause of the curtailment of individual and racial existence—absolutely prohibits the development of parental and subsequent social instincts, seeing that the act of reproduction very generally means early if not instant death to a parent already exhausted by a parasitic diathesis. Anything approaching the beginnings of sociability and education of the young in the animal world must needs be dependent on the healthy survival after reproduction, and capacity for further sacrifice on the part of the parents. A legitimate metabolism is the only guarantee of such desiderata.

In many cases, as Darwin instances in the *Descent of Man*, the diminutive male falls a prey to female cannibalism—a state of domestic affairs which leaves little scope for auspicious social developments.

Only a few plant-feeding types among the invertebrates, especially the beetle tribe (*Lethrus cephalotes*), distinguish themselves by domestic virtues containing the prophecy of the higher life.

In contrast to these we find examples, even among so high a class as the mammalia, of males devouring their own young; they are confined to predaceous and carnivorous types: wolf, bear, and tiger.

Among the frugivorous apes, on the other hand, we find males nursing the baby, and males very generally assisting in the building of the nest.

The gorilla holds night-watch under the tree where his family is dwelling; the chimpanzee sleeps on a bough beneath the nest.

Gregariousness is especially marked among the herbivorous cattle, antelopes, sheep, deer, elephants, camels, horses, etc., and reaches a high degree of perfection among the apes, among which monogamy is well marked and family life a distinct feature.

It is quite evident that the predaceous types and parasites, being the most fastidious as regards their food, are, teleologically speaking, the most precariously placed, for whilst plant-feeders have meadow and field, shrubs, forests, and plantations at their disposal, and can thus afford gregariousness and social life, the former, depending on more casual supplies and being thus reduced to deadly strife and competition, apart from the direct pathological nemesis, cannot attain to a satisfactory social organisation.

§ 4. *The Case of Interior Parasites*

The case of the interior parasites clearly shows that destruction is proportional to the intensity of dysteleological developments. Given such degeneracy, it appears to be a matter of "chance" whether any of the vast number of their eggs which are passed out with the excreta succeed in infesting the interior of a herbivore (the intermediate stage required in this vicious circle of life), which in its turn has to be "swallowed" by a carnivore, the whole of this circuitous process being necessary to ensure the arrival at its true destination of the parasite. Yet it is not so wonderful as might be supposed that this vicious round nevertheless operates with a certain amount of precision, for it must not be forgotten that the carnivore, having once lapsed in the direction of depredation and thus begun to create affinities of the pathological order, and to lay up the soil for parasites to batten upon, has *got* to feed the colonies of interior parasites infesting him, and is thus impelled to feed increasingly in a direction fatal to his own life—*i.e.* dysteleologically. Although in the case of pathogenic bacteria it is admitted that those originally innocuous organisms owe their virulence not so much, as it were, to their inherent properties as to the peculiar pathological condition of certain hosts, it is quite usual not to draw the obvious inferences. But is it conceivable that an organism actually littered by colonies of parasites—in the body of a young horse Krause found 500 *Ascaris megalocephala*, 190 *Oxyuris curvula*, several millions of *Strongylus tetracanthus*, 214 *Sclerostomum armitum*, 287 *Filaria papillosa*, 69 *Tænia perfoliata*, and 6 *Cysticercus fornis*—could persist in anything approaching a normal metabolism? that its tastes and general sense of proportion (its autonomy and potency in respect of environment) could remain undistorted?

It is quite true that—for a time—parasites multiply enormously, but it is utterly childish to jump to the conclusion which would impute a direct teleological instinct to their redundant multiplication, that this enormous over-production is proceeded with "in order to prevent extinction." Thus K. Kraepelin, in his *Die Beziehungen der Tiere zu einander und zur Pflanzenwelt*: "Es mussten daher von allen Endoparasiten, sollte die Art vor dem Aussterben gewahrt bleiben, aussergewöhnlich grosse Mengen von Eikeimen produziert werden, um auch bei denkbar ungünstigen Verhältnissen den Erfolg zu sichern, und so kann es nicht wundernehmen, dass diese Eier der Spulwürmer, Saugwürmer, Bandwürmer zum Teil nach Millionen zählen, von denen dann, wie schon früher ausgeführt, durchschnittlich aber immer nur eines als Ersatz des Muttertieres zur vollen Entwickelung kommt." ("All interior parasites, therefore, in order to preserve the species from extinction, must produce excessive numbers of germs to be successful even under the worst conceivable conditions. Thus it cannot cause surprise if the eggs of threadworms count by the million, of which, however, but one on the average arrives at full development to replace the mother animal.")

He is careful enough, however, to add: "Die ungemein günstigen Ernährungsverhältnisse des Parasiten inmitten der Säfte des Wirtstieres stellen jedenfalls einen Faktor dar, der bei der Ausbildung jener enormen Eiproduktion eine wichtige Rolle spielt." ("The eminently favourable conditions of obtaining food from its situation in the full current of the host's nutritive fluids, must in any case be considered an important factor in the enormous production of eggs.")

In *Nutrition and Evolution* I have attempted to show that all phenomena of prodigious multiplication must be studied with a due regard to the principle of dissociation, and referred to the time-element. In the mineral world dissociation, with all its prodigious concomitants, is hastened by illegitimate associations—impurities; and the same cause—illegitimate unions in nutrition, or "infeeding"—brings about dissociation and pathology in the organic world. I have given numerous examples from the abounding evidence available both in the plant and animal worlds.

Kraepelin instances the case of the carnivorous *Drosera*. When richly, though illegitimately, provided with insects, the production of seeds was raised to five times what it was in the normal unsurfeited condition. Examples of this kind can easily be multiplied; they represent cases of a morbid (dysteleological) acceleration of life-processes induced by infeeding.

§ 5. *The Alleged Constancy of Species*

If it be that, normal or abnormal modes of reproduction notwithstanding, there yet always remain, on a very broad survey of the question, a certain constancy of species, this can only mean that the total zoological family has always room for a certain number of definitely functioning equilibria, much in the same way as the individual body has for a multiplicity of organs. This, however, in no way invalidates the fact that pathological elements (and frequently whole branches) have by way of teleological adjustment[1] to be eliminated from the aggregate of a particular organism or species. Fortunately, our ideas respecting "constancy of type" are, as a consequence of wider study, undergoing great change at the present day.

§ 6. *Experiments regarding Infeeding and Reproduction*

Biological experiments are no less unequivocal as regards the results of infeeding, although, of course, the interpretations differ, and must differ as long as the fact of organic dissociation remains unrecognised by the majority of experimenters.

Thus Maupas observed that, in regard to a common infusorian (*Leucophrys patula*), with plant nutrition (legitimate cross-feeding) the rate of asexual reproduction is much less than with animal nutrition, reproduction tending towards conjugation rather than towards fission. In the same way, Yung, who fed tadpoles alternatively on beef, fish, and frogs' flesh (notice the gradual intensification of the infeeding) obtained the following results as regards the ratio of male and female: first brood shows that the percentage of females varies from 54 to 78; second brood, from 61 to 81; third brood, from 56 to 92. The tadpole in the normal state is a cross-feeder, but Yung, by means of infeeding, brought to bear a disaggregating force upon reproduction.

---

[1] Ch. Depéret states: "When a branch disappears by extinction, it is, so to speak, *replaced* by another branch *having an evolution until then slower*."

The way in which close infeeding projects antithetic disaggregation as well upon an individual as upon the aggregate of a species may again be gleaned from the following instances, taken from *Knowledge*, vol. vi., No. 8, p. 315:—"It might well have been imagined that we knew almost all that there is to be known regarding the life-history of such a comparatively common British mollusc as the slipper-limpet (*Crepidula fornicata*), but specimens recently taken at the mouth of the river Crouch, a couple of which are exhibited in the British Musuem, show a phase which appears to have been hitherto undetected. These limpets have depressed, oval shells, with a kind of pocket inside, from which they take their name; and when young move about after the fashion common to limpets generally. Later on, however, they collect into chains, one overlying the other, and comprising from two to a dozen individuals, of which the lowermost is attached to a shell or some other object. The most curious feature about these chains, according to a paper communicated recently by Mr J. H. Orton to the Royal Society, is, however, the circumstance that the individuals near the attached end are females, and those at the opposite extremity are males, while those occupying the middle portion are intermediate as regards sexual characters between females and hermaphrodites on the one hand, and between males and hermaphrodites on the other. Hence it seems to be demonstrated that, while these molluscs commence their lives as males, they end by becoming females.

"The above-mentioned phenomenon—that is to say, males becoming females with advancing age—is, however, by no means peculiar to the slipper-limpet. It occurs, for instance, among the members of those degraded isopod crustaceans, known as epicarids, which in the adult condition are parasitic upon other members of their own class. Among these is the genus *Dajus*, belonging to a group of four families, the representatives of which usually infest decapod crustaceans."

Although degradation of a species is thus clearly the result of habitual infeeding, Sir E. Ray Lankester declares that, so far as *a priori* argument has any value in the matter of animal nutrition, "it suggests that the most perfect food for any animal is the flesh and blood of another animal of its own species" (*Daily Telegraph*, 12th December 1909).

§ 7. *The Analogies of Fertilisation*

The good reproductive effects of plant nutrition adduced above, must be considered analogous to those of cross-fertilisation in plants (as opposed to self-fertilisation). A flesh diet in the long run conduces to inbreeding and hermaphroditic union favouring the asexual and parthenogenetic (degenerate) modes, with liability to extinction rather than normal sexual modes of propagation. In other words, it spells limitation, degeneracy, and retrogression.

In the conjugation of the infusorian as opposed to mere fission we have a decided step towards a more teleological reproduction, for conjugation is a primitive form of fertilisation. Fertilisation, however, implies mingling of qualities ("Qualitätenmischung"—Weismann's amphimixis[1]) and rejuvenescence, and it is the condition of the continuity of life. According to Hensen: "By normal fertilisation, death is warded off from the germ and its products."

The asexual mode, however, is more primitive—mere increase of growth—merely having the faculty of forming an independent organism, but destitute of the permanent element of Qualitätenmischung (amphimixis)—"eine Wachstumserscheinung des mütterlichen Organismus, die, wenn sie eine gewisse Grösse erreicht hat, zu selbständiger Existenz befähigt wird."

---

[1] "A process," according to Weismann, "by means of which one-half of the number of nuclear rods is removed from a cell and replaced by an equal number from another germ-cell."

It is clear that with fertilisation (as distinguished from the asexual mode) an organism attains a higher teleological position,[1] and it is equally indisputable that a legitimate metabolism is the *sine qua non* of such progressive evolution.

It is significant in this connection that as a prerequisite of this vital phenomenon of fertilisation there must take place a series of reduction (maturation) processes, purporting a return to fixed primordial arrangements, analogous to those I have stated to obtain as regards nutrition (such writers as Eimer, Hatschek, Rolph, Geddes and Thomson, Spencer, and Claude Bernard consider that fertilisation is indeed a kind of nutrition).

The maturation of sex-cells entails "Einzelligkeit" (*i.e.* the unicellular condition), from which alone the new organism can arise. As E. Teichmann points out in his *Der Befruchtungsvorgang*: "Geschlechtliche Fortpflanzung dagegen geht immer auf den Zustand der Einzelligkeit zurück. Jeder geschlechtlich erzeugte Organismus nimmt seinen Ursprung aus einer Zelle, aus dem befruchteten Ei. Das muss so sein, wenn das Wesentliche der geschlechtlichen Fortpflanzung in einer Mischung von Qualitäten liegen soll. Wie denn könnte diese zustande kommen, wenn nicht durch Vereinigung zweier Zellen? Ausgewachsene Individuen können nicht zu einem Wesen verschmelzen.

---

[1] "La génération sexuée n'est peut-être qu'un luxe pour la plante, mais il fallait que l'animal y vint, et la plante a dû y être portée par le même élan qui y poussait l'animal, élan primitif, originel, antérieur au dédoublement des deux règnes."—*L'Evolution Créatrice.*

Wohl aber liegt das im Vermögen des Organischen, solange es noch im Zustande der Einzelligkeit ist." ("Sexual reproduction always spells a return to the unicellular condition. Every sexually produced organism originates from a single cell, the fertilised egg. This must be so if a mingling of qualities is to be the rationale of sexual reproduction. How then could such mingling be achieved except by the union of two cells? Adult individuals cannot coalesce into a single being. Such coalescence, however, is well within organic possibilities when the organism is still in the unicellular state.")

"Soll Qualitätenmischung erzielt werden, so ist einzelliger Zustand die notwendige Voraussetzung." ("If mingling of qualities (amphimixis) is to be attained, the unicellular state is the indispensable prerequisite.")

"Keimzellen vereinigen sich nicht, damit ein neues Individuum entstehe, sondern das neue Individuum entsteht aus einer Zelle, damit Qualitätenmischung stattfinde." ("It is not that germ-cells unite in order that a new individual may arise, but it is rather that the new individual takes its origin from a single cell in order that a mingling of qualities may take place.")

"Das Wesen der Befruchtung liegt in der Addierung der elterlichen Qualitäten." ("The essential condition of fertilisation is the blending of parental qualities.")

This writer then emphasises the teleological significance in reproduction. It is not to increase existing numbers, but rather to raise the level of being through amphimixis, *i.e.* through teleological processes of maturation and union, that the process of fertilisation was instituted. In the same way it must be declared of nutrition that its rationale is teleological, that its end is not merely to produce growth, but to satisfy those primordially indicated requisites of teleological union (cross-feeding, entailing blending of permanent elements) by means of which alone elevation of status is possible.

The costliness of the maturation process, again, is great, and strikingly reminds us of the sacrifice entailed by the conjugating infusorian, which, as we have seen, under the auspices of a vegetarian nutrition, surrendered the more dysteleological mode of fission.

Says Teichmann: "Soll er die Bedingungen schaffen, unter denen Qualitätenmischung durch die beiden Geschlechtszellen möglich wird, so muss die Chromosomenreduktion in der Weise vorgenommen werden, dass die reife Geschlechtszelle einen Kern erhält, der mit der ganzen Qualitätenkombination ausgerüstet ist, diese aber nur in der Einzahl besitzt. Solches wird erreicht, indem sich die homologen Qualitätenträger paaren und dann unter dem Bilde und mit dem Mittel einer Mitose die Trennung und Verteilung der gleiche Qualitäten repräsentierenden Paarlinge auf zwei Zellen durchgeführt wird. Nun enthält die Keimzelle an Kernsubstanz nur das, aber auch alles das, was notwendig ist, wenn aus ihrer Vereinigung mit einer anderen Keimzelle der typische Chromatinbestand der Art in neuer Mischung hervorgehen soll." ("If the maturation-process is to produce the conditions under which alone a mingling of qualities on the part of both germ-cells is possible, the reduction of chromosomes must proceed in such a manner that the mature germ-cell contains a nucleus equipped with the whole combination of qualities, of which, however, it must contain only a single group. The end is gained by a pairing of homologous carriers of the parental qualities, the separation and distribution of such pairs (representing homologous qualities) being subsequently attained by means of mytosis. Ultimately the germ-cell must contain of nuclear substance *only that*, *but all that*, which is necessary, if from its union with another germ-cell there is to arise the newly mingled aggregation of hereditary substance typical of the particular species.")

In other words, the maturation process is marked by a rejection of such superfluities as entail more or less costly eliminations, determined by the teleological suitability or otherwise of specific nutrition, the expense of which we can approximately gauge when we remember the all-important bearing that even the subtlest processes in the embryonic stage must have on future developments.

Darwin, by his classical experiments with plants, has shown that "Nature abhors perpetual self-fertilisation," which, as I have shown in *Nutrition and Evolution*, is a consequence of a parasitic diathesis, and I have therefore ventured to expound the dictum as implying that "Nature abhors parasitism."

The great naturalist has shown by what wonderful contrivances and under what enormous sacrifices plants strive to attain the more progressive and elevated condition of cross-fertilisation. The same holds true with regard to the tendency in the animal normally making for conjugation (fertilisation) rather than fission (mere growth or division), and the same impediment to progress exists here as there in the shape of over-feeding or (parasitic) infeeding.

Maupas found that with infusoria the costliness of conjugation was immensely higher than that of fission: "While a pair of infusorians (*Onychodromus grandis*) were indulging in a single conjugation, another had become, by ordinary asexual division, the ancestor of from forty thousand to fifty thousand individuals. Moreover, the intense internal change preparatory to fertilisation, and the general inertia during subsequent reconstruction, not only involve loss of time, but expose the infusorians to great risk. It seems then like a condition of danger and death rather than multiplication and birth."

Were there no teleological rationale, we might thus indeed say that conjugation to the infusorian means a waste, just as we saw Darwin putting the question: What would it benefit the intestinal worm to be highly organized? and as it has indeed been asked: "Why should fertilisation occur at all, if parthenogenesis in some cases works so well?" But on teleological lines it will be found that permanence, stability, and elevation of status can scarcely be purchased at too high a cost.

The antithesis of numbers (40,000 to 50,000 individuals from division, as opposed to the poor numerical result from the alternative of conjugation) in the above experiment is illustrative of the antithesis of teleological status as marked by the respective modes of reproduction, and, at the same time, of the antithesis involved in the respective modes of nutrition. The teleological rationale then determines the measure of the sacrifice entailed in fertilisation as well as the paucity of numbers entailed in conjugation. This is approximate to the manner in which inversely habitual infeeding (not mere chance of position) determines "struggle" and "extermination" of organisms destitute of the permanent elements entailed in cross-feeding.

In the same way with plants, the advance from self-fertilisation to cross-fertilisation must be viewed as a teleological advance along the lines of an increased sentience (a "more of life") irrespective of numbers, the primitiveness of the former state being primarily founded in a relatively dysteleological metabolism.

§ 8. *Nutrition determining Fertilisation*

The way in which fertilisation is associated with and determined by nutrition may also be gleaned from the following instance related by R. H. Lock in his *Variation, Heredity, and Evolution*:—"A grain of Indian corn or maize contains a germ or *embryo*, which, under suitable conditions, will give rise to the future plant. The embryo is surrounded by a certain amount of reserve food-material constituting the *endosperm*—a store which is made use of by the young plant during its germination. The embryo arises as the result of a process of fertilisation which takes place in the following manner: The ovum or female cell hidden in a flower, contains a nucleus, and this, on fusion with one of the nuclei derived from a grain of pollen, initiates the vital processes which lead to the development of an embryo plant.

"Nuclei are the central and, from the point of view of heredity, the most important parts of cells—the constituent units of the plant body. The cells which, together with their nuclei, take part in the process of fertilisation are known as *gametes*, or *germ-cells*—male and female respectively, the latter being the ovum.

"It is less generally known that the endosperm of a grain of Indian corn arises by a very similar process to the one which gives rise to the embryo itself. A second nucleus derived from the same pollen grain fuses with a nucleus situated near the ovum, and to the product of this fusion the endosperm owes its origin. It is further found, so far at least as those characters are concerned to which we shall at present confine our attention, that these two important nuclei hidden in the same female flower are exactly alike in hereditary constitution, and so are the two generative nuclei derived from a single pollen grain. In consequence of this fact, the observed character of the endosperm may be regarded as a true guide to the nature of the plant into which the associated embryo will afterwards develop. The hereditary qualities of the two are exactly the same."

Thus we have the wonderful fact that both in hereditary constitution and in important hereditary qualities the nucleus of endosperm and that giving rise to the embryo itself are alike. In other words—if we at the same time allow for the qualitative effects of nutrition, which Lock fails to do—we may say that nutritional states, as they determine embryonic morphology and survival on the embryonic plane, also largely determine the value of fertilisation (and hence, of course, also adult morphology and adult survival). At the same time the above example supports my view that primordial and teleological requisites obtain in nutrition as well as in fertilisation. That the writer just quoted from under-estimates the force of habit, and because he lacks a qualitative rationale is apt to underrate the cumulative and determinative force of nutrition, is clearly evident from the following passage on another page concerning the transmission of character in heredity: "Indeed, at the present day the consensus of opinion among experts is undoubtedly to the effect that acquired characters are not inherited at all, except in so far as better nutrition of the parent may lead to the production of more vigorous offspring. And it seems clear that such an effect as the latter cannot go on accumulating for more than a few generations."

The problem of the accumulation of nutritive effects is a matter of qualitative and quantitative analysis, and cannot be disposed of in such offhand fashion.

SUMMARY

Nutrition and reproduction are, normally, means towards the attainment of stability and of progress, which becomes apparent in the ever-increasing beauty and serviceableness of forms. The case of conjugation shows that nutrition and reproduction are intimately associated. In so far as reproduction is not directly pathologically indicated, we must view its occurrence as the assertion of the potential racial power *vis-à-vis* the individual, *i.e.* race becomes prepotent over the individual. This may be due either to the power of ancestral dynamics or to inherent maturity, *i.e.* readiness to receive potential enhancement combined with the teleological duty to the race by perpetuation and improvement of the stock. What is described as a "gnawing hunger," leading to the engulfing of a neighbour in "isophagy," represents a morbid exaggeration due to metabolic transgressions. This conclusion can be experimentally verified.

The fixity of metabolic ratios is founded on important primordial requisites. Physically speaking, the import of this arrangement seems to be to produce the maximum of teleological result with a minimum of waste.

For æons of time the plant world has under many reciprocal arrangements teleologically provided animal sustenance. All animal development and morphology derive their legitimacy from such primordial adjustments.

The wastefulness charged against Nature in the matter of destruction of seeds is in reality the result of transgressions against metabolic ratios.

The yolk-glands are a striking example from the embryonic sphere, and present physiological and diagnostic evidence of the manner in which a parasitic diathesis is projected upon reproduction and sex. Nature's endeavours to compensate for nutritive anomalies by reproductive sacrifices are severely handicapped by parasitism.

Only a few plant-feeding types among the invertebrates distinguish themselves by domestic virtues containing the promise of the higher life.

Among the carnivorous mammalia some are found to devour the young, which is a sufficiently obvious reversal of the natural order necessary to the persistence of the species.

Gregariousness and sociability are specially marked among plant-feeders, which, owing to a more teleological mode of nutrition, are less precariously placed than flesh-feeding types, and are rendered specially capable of developing the higher social and other instincts and qualities.

The case of interior parasites shows that destruction is proportional to the intensity of dysteleological developments. The parasite creates affinities which increasingly impel him to feed dysteleologically.

The alleged constancy of species does not invalidate the fact that pathological elements are constantly in course of elimination by the method of teleological adjustment.

Maupas has shown by experiment that in the case of a common infusorian with plant nutrition (legitimate cross-feeding) the rate of asexual reproduction is much less than with animal nutrition, reproduction tending towards conjugation rather than fission.

In the same way Yung's classical experiment with tadpoles shows that infeeding implies the projection of a disaggregating force upon reproduction.

The good effects of plant nutrition (cross-feeding), as opposed to infeeding, are analogous to those of cross-fertilisation in plants (as opposed to self-fertilisation) and asexual modes of reproduction.

Fertilisation involving maturation (reduction) processes previous to mingling of qualities, spells teleological reproduction and advance of status—a legitimate metabolism (proper cross-feeding) being the *sine qua non* of such progressive evolution.

Fertilisation involves a return at the genesis of every organism to the primordial unicellular condition. Comparable to this essential feature is the teleological requisite of cross-feeding, on which the life of the total zoological organism is pre-eminently based.

Nutrition and fertilisation do not involve merely growth and multiplication, but rather a raising of teleological status along the lines of least resistance. The maturation process is marked by a rejection of superfluities, entailing more or less costly eliminations—the waste being determined by the teleological suitability or otherwise of the specific habit of nutrition.

Stability and elevation of status can scarcely be purchased at too high a cost. Nutritional states, as they determine embryonic morphology and survival, also fundamentally affect adult morphology and survival.

CHAPTER II

HERMAPHRODITISM

"Parasitism means not only abundant, but rich and stimulating nutrition."—GEDDES and THOMSON.

§ 1. Degrees of Hermaphroditism.
§ 2. Partial Hermaphroditism.
§ 3. Connections with Parasitism.
§ 4. Distortions of Dichogamy.
§ 5. A Surplus of Material.
§ 6. Unisexual Differentiation a Matter of Teleological Development.
§ 7. Progressive "Degeneration."
§ 8. Imaginary *a priori* Grounds for Female Preponderance.

§ 1. *Degrees of Hermaphroditism*

IN *Nutrition and Evolution* I have already dealt with the subject of plant hermaphroditism. It now remains to consider the subject generally and systematically. In the *Evolution of Sex* we are told: "When an organism combines within itself the production of both male and female elements, it is said to be bisexual or hermaphrodite. This is the case with most flowers, and with many lower animals—such, for instance, as earthworms and snails. It is not desirable to extend the term, as is sometimes done, to cases like ciliated infusorians, where sex itself is only incipient.

Undoubtedly in those Protozoa recent researches have distinguished what in loose analogy may be called male and female nuclear elements, but this primitive condition is rather a state antecedent to sex, than a union of sexes in one organism."

At once we see the necessity of discriminating between primitive and pathological forms of hermaphroditism. What is here surmised to be a state antecedent to sex, may indeed present the true primitive form of hermaphroditism, whilst the more conspicuous forms may but represent reversions to it.

The fact that "embryonic hermaphroditism" occurs sometimes even in unisexual animals ("demonstrated as of normal occurrence in frog tadpoles"), as it illustrates the great plasticity of sex, seems to point to a reversion towards a more primitive state due to pædogenetic developments.

The same may be said of cases commonly considered as casual or abnormal hermaphroditism. "In many species which are normally unisexual, a casual hermaphrodite form occasionally presents itself. The embryonic equilibrium or bisexuality—one of the two must in variable degree exist — is retained *as an abnormality* into adult life."

Amphibians, "which abound in reproductive peculiarities," the common frog and the cod, herring, mackerel, and many other fishes are instances.

That retention of bisexuality as an abnormality can be traced to dysteleological habits will presently be more fully demonstrated.

§ 2. *Partial Hermaphroditism*

The snail, earth-worm, and leech are supposed to be examples of partial hermaphroditism—anatomic and physiological—in varying degree of intimacy.

"But, as we have just noticed, a species normally unisexual may occasionally exhibit hermaphrodite individuals."

"To those must now be added a further series of cases to which the term partial hermaphroditism seems most applicable. Only one kind of sexual organ, ovary or testis, is developed; but while one sex preponderates, there are more or less emphatic hints of the other. As the reproductive organs are to be regarded as the most important, *but not by any means the sole expression* of the fundamental sex-differences, it is impossible to separate partial hermaphroditism by any hard and fast line from the above, and from the next set of cases. Almost all cases of partial hermaphroditism *occur as exceptions*, though a few are constant."

Again, this points to a fundamental and universal cause, and it becomes increasingly evident that for the greater part we are dealing with pædogenetic and antithetic developments.

We are also told that: "The reproductive organs proper, the ducts, and the external parts are developed upon the same plan in male and female."

These facts of observation correspond with normal developments; by abnormal nutritional modes, however, the progress of normal development is disturbed, with the result of disharmony and limitation of development.

§ 3. *Connections with Parasitism*

Coming to "normal adult hermaphroditism," we are told that it is "rare among the higher animals, but common among the lower." This is what, on my views concerning teleological status, we should expect.

"Among invertebrates, true hermaphroditism is, however, of frequent normal occurrence, *e.g.* in sponges, cœlenterates, worm types, and molluscs."

"Many sponges are only known in a unisexual state, while others are genuinely hermaphrodite. But among the latter it is not uncommon to find (*e.g.* in *Sycandra raphanus*) that the production of one set of elements preponderates over the other, and thus we have hermaphrodites with a distinctly male or female bias. In other words, they are verging towards unisexuality. It does happen, in fact (*e.g.* in *Oscarella lobularis*), that a species normally hermaphrodite may exhibit unisexual forms."

"The genus *Corallium* (the red coral of commerce) is peculiarly instructive. The whole colony may be unisexual, or one branch of the colony, or only certain individuals on a branch, while genuine hermaphroditism of individual polyps also occurs."

Just as in plant life we have the institution of dichogamy, so we find among the lower animals a tendency to transcend limitation, and much in the same way as plants achieve this end under great reproductive sacrifices, so we find here "progressive dissociation" affecting the sex elements. The explanation furnished by Geddes and Thomson to account for these gradations of hermaphroditism is that some portions are "better nourished" than others. Indeed, when we find them introducing their "constitutional bias," we may conclude that parasitism is not far to seek.

First our attention is called to the case of "Worms."

"The condition of the sexual organs varies enormously among the diverse types lumped together under the title of 'Worms' or 'Vermes.' In the lowly turbellarians, all the genera are hermaphrodite except two, but, as in many other cases, the organs do not reach maturity at the same time, the male preceding. In the related trematodes or flukes, hermaphroditism again obtains, with one exception, or perhaps two. The certain exception is the curious parasite *Bilharzia*, where the male carries the female about with him in a 'gynæcophoric canal,' formed of folds of skin. In the adjacent class of cestodes or tape-worms, all the members are hermaphrodite. These three classes are doubtless related, *but it seems plausible to connect the retention of hermaphroditism with the degeneracy of parasitism*, and also *with the rich, yet at the same time stimulating, nutrition, which may favour the retention of double sexuality.* The utility of the hermaphrodite state, if the eggs of these animals are to be fertilised and the species maintained, can hardly be doubted, but this does not explain the facts. It is important to notice, too, that self-fertilisation—that is, union of the eggs and sperms of the same organism—has been proved to occur in several trematodes, and seems to be almost universal in cestodes. *This may be one of the conditions of the degeneracy of these parasites*, for frequent as hermaphroditism is among plants and animals, self-fertilisation is extremely rare."

Although the "plausibility" of the connection with parasitism is so striking that to an unbiassed mind it must surely approach the stage of certainty, many writers thus affect to entertain solemn doubts in the matter.

It is obvious that the degeneracy of the precarious parasitic life entails expedients, seeing that, notwithstanding nature's "time-keeping" tendency (to obviate self-fertilisation by dichogamy), these animal parasites present the extreme example of actual self-fertilisation, and it becomes equally obvious, again, that the old "utility" argument is utterly futile.

The authors even go so far as to remind us of the physiological impossibility of developing the two kinds of cells simultaneously. Even in hermaphroditism, "there is (normally) throughout, in varying degrees, a tendency to periodicity in the production of male and female elements." . . . "Antagonistic protoplasmic rhythms may rapidly alternate, but cannot co-exist." Yet, it is not admitted that it is parasitism that upsets the rhythm and constitutes the real disharmony.

"The very physiological conditions which first determined the position of the ovaries here and the testes there, may remain to render it possible for the two opposing functions to go on at the same time."

The only cogent explanation of the disharmony is the retarding and limiting effect of parasitism, the "rich nutrition" which prevents progressive sexual differentiation.

"Hermaphroditism is rare among the free-living nemerteans, but constant in the semi-parasitic leeches." . . .

"Among crustaceans, hermaphroditism is a rare exception, though it occurs in the majority of the fixed quiescent acorn-shells and barnacles (Cirripedia)." . . .

"Most bivalves are of separate sexes, but exceptions often occur—*e.g.* in common species of oyster, cockle, clam, etc. In the case of the oyster, the familiar species (*Ostrea edulis*) is hermaphrodite, and a neighbouring species apparently unisexual. In both cases the organs are the same, but in *O. edulis* the same intimate recesses of the reproductive organ produce at one time ova, at another time sperms."

All these instances unmistakably point to the fact that parasitism is the universal cause of curtailment and limitation of life.

§ 4. *Distortions of Dichogamy*

"It is believed by breeders of higher animals that 'close-breeding' beyond a certain point is dangerous to the welfare of the breed. The offspring tend to be abnormal or unhealthy. In view of this, the rarity of self-fertilisation among hermaphrodites has been explained in terms of the disadvantage of the process. In reality, however, this is putting the cart before the horse. In hermaphrodites, we take it that the two kinds of sexual elements mature and are liberated at different times, not because of any reaction of the disadvantageousness of self-fertilisation on the health of the species, but simply because the simultaneous coexistence of opposite physiological processes is *in varying degrees* prohibited. More technically, dichogamy is not a subsequent result of the disadvantage of self-fertilisation, but cross-fertilisation is the subsequent result of increasing dichogamy."

Even if we were to concede some cogency to this reasoning, we would yet have to ask, What is it that so frequently prohibits the harmonious operation of those opposite physiological processes? Is it not, in the first place, the parasitic diathesis which upsets the normal functions of the organic see-saw and causes all these antitheses? Is it not the subsequent intensification of the disease which distorts even the remaining vestiges of rhythm and of normality? If, finally, the "opposite physiological processes" are really seen to co-exist simultaneously, is this limitation not related to the previous pathology of parasitism as reaction is to action?

Dichogamy may indeed be viewed, not as a result of the disadvantage of self-fertilisation, but as the expression of an inner transient stage, whence an organism may either reach the genuine condition of normal cross-fertilisation, or in the alternative degenerate further in the direction of cestodes, tapeworms, and ostreæ.

In *Nutrition and Evolution* I have alluded to the dangers of reversion to which the dichogamous arrangement is liable, and it was shown that the practical breeder's view connecting close-breeding with pathology is fully justified.

The morbidity of inbreeding so frequently met with in cattle is merely of a milder type than that presented by the following cases of distorted dichogamy.

"Self-fertilisation does, however, occur as an exception among animals,—thus in all probability in the exceptional fish *Serranus*; *certainly in many parasitic flukes* or trematodes; 'commonly, *if not universally*,' in *tape-worms or cestodes*; also in the curious thread-worm *Angiostomum*, and probably in ctenophores, and in some other cases."

The decrease of dichogamy is thus clearly another striking instance of a retributive limitation and curtailment resulting from a dysteleological mode of life.

§ 5. *A Surplus of Material*

But it is in their consideration of the "conditions" and of the "origin of hermaphroditism" where Geddes and Thomson, endeavouring to show that "the conditions, in part, involve a surplus of material," find themselves driven almost to own the pathological connection.

"In looking back over the cases where normal hermaphroditism occurs, a few general conclusions are readily drawn. Thus Claus points out that hermaphroditism finds most abundant expression *in sluggish* and fixed animals. Flat-worms, leeches, earth-worms, tardigrades, land snails, etc., well illustrate the first of these; and among sponges, sea-anemones, corals, polyzoa, bivalves, etc., we find frequent illustration of the association of fixedness and hermaphroditism. Most of the tunicates are also fixed, and all are hermaphrodite. Claus notes, further, how in flukes and tape-worms hermaphroditism is associated with an isolated habit of life. The isolation, however, is only sometimes true, for flukes may occur near one another in great numbers; and as many as ninety tape-worms (*Bothriocephalus*) have been known to occur at one time in a single host.

"Simon has gone further, *in insisting on the real connection between quiescent and parasitic habit* and the *hermaphrodite* condition. In flukes and tape-worms, leeches, Myzostomata, and some cirripedes, *we find the association of hermaphroditism with a more or less intimate parasitic habit.*

"It will be remembered, too, that the hagfish, in which hermaphroditism is common, is also to a large extent a parasite. But what Simon points out is, that organisms on which great demands are made, especially in the way of muscular exertion, cannot afford to be hermaphrodite; *while a plethora of nutrition*, as in parasitism, tends to make the persistence of the double state possible. He gives numerous illustrations of this very reasonable contention.

"For it seems plausible that with more available material for internal differentiation, such should actually occur. But it is possible to venture still further.

"*A sluggish habit is usually associated with a large surplus of nutritive material*, and at the same time very frequently *with an accumulation of waste products.* Parasitism means not only abundant, but rich and stimulating nutrition. Conditions which combine these two factors will tend to *secure the persistence of primitive hermaphroditism, or even to develop it from a previously attained unisexual state.* It must be noted, however, that exceptions occur, which it is at present difficult to explain. The ctenophores are all hermaphrodite, yet very active. So, too, are not a few tunicates; while the brachiopods are extremely passive, but not specially characterised by hermaphroditism."

Sluggishness thus again shows to little advantage. Likewise the "isolation" argument by itself is seen to be futile.

The statement that such "internal differentiation" as hermaphroditism arises from the fact of more available material, of a plethora of nutrition with an accumulation of waste products, marks an advance towards a more rational explanation. It is equally commendable to find Geddes and Thomson conceding that "parasitism means not only abundant, but rich and stimulating nutrition." But all this is still too vague, and is lamentably lacking in precision of analysis and in the application of criteria.

Simon should have gone a step further and traced the connection between parasitism and pathology, showing that parasitism, rather than making the double state possible, renders limitation unavoidable. Parasitism cannot be a disease and a utility (except indirectly) at one and the same time, and it is quite illegitimate to speak of an abundance of available material for internal differentiation in this connection. The inability to gauge the pathology of the case accounts for the difficulty of explaining exceptions.

§ 6. *Unisexual Differentiation a Matter of Teleological Development*

"There can be very little doubt that hermaphroditism was the primitive state among multicellular animals, at least after the differentiation of sex elements had been accomplished. In alternating rhythms, eggs and sperms were produced. *The organism was alternately male and female.* Of this primitive hermaphroditism, there is probably more or less of a recapitulation in the life-history of all animals. Gegenbaur states the common opinion in the following cautious and terse words: 'The hermaphrodite stage is the lower, and the condition of distinct sexes has been derived from it.' Unisexual 'differentiation, by the reduction of one kind of sexual apparatus, takes place at very different stages in the development of the organism, and often when the sexual organs have attained a very high degree of differentiation.' The first structural change in the separation would probably be the restriction of areas, in which the formation of two kinds of cells still went on at different times in one organism. In different individuals the opposite tendencies we have already spoken of more and more predominated, till unisexuality evolved out of hermaphroditism."

"We may in brief suggest as the three probable grades in the history: (*a*) the liberation of unindividuated sex-elements; (*b*) the formation of two diverse kinds of sex-elements, incipiently male or female, at the same time, or at different periods, according to nutritive and other conditions; (*c*) the unisexual outcome, where the production of one set of elements has preponderated over that of the other.

"As at present existing, hermaphroditism may be interpreted *as a persistence of the primitive state, or as a reversion to it.* Individual cases must be judged by themselves, and the history of each must be taken into account. But where the hermaphroditism is manifestly exceptional, there can be seldom any question in regarding it as a reversion. The reversion would generally occur on the female side, for on *a priori* physiological grounds it is, as Simon remarks, more readily intelligible that a female should produce sperms than that a male should produce ova. In this connection it is interesting to notice how Brock, in regard to the development of the reproductive organs of snails, maintains that they are laid down and developed on the female type, and only become secondarily hermaphrodite. Purely female forms still occasionally occur, which he interprets as exaggerations of the side normally preponderant. So in hermaphrodite bony fishes, the same author has shown that the preponderance is distinctly female.

"Hermaphroditism is associated in some cases (*e.g.* Polyzoa) with the occurrence of parthenogenesis in allied forms; and it may be noted, as will become clearer afterwards, that for a female to become hermaphrodite is a sort of step towards parthenogenesis. It means that certain cells of the reproductive organs are able to divide of themselves, to form, however, not an embryo, but a bundle of sperms.

"The general conclusion then is, that hermaphroditism is the primitive condition, and that the cases now existing either indicate persistence or reversion."

This is a highly interesting outline of the history of hermaphroditism, and I quite agree that "individual cases must be judged by themselves, and the history of each must be taken into account" (most important considerations, provided proper criteria are used in our analysis).

If it be true that in a primitive state all organisms were alternately male and female, we can understand —remembering, moreover, the community of descent and Dohrn's principle that the living protoplasm retains all the traces of its previous functions, which may now appear more specialised and now more reduced —that there is not sufficient room for the exaggerated constitutional sex-distinction made by Geddes and Thomson, but that, on the contrary an homologous constitution for both male and female is normally handed on, and that the tendency is to impress the generic characteristics pre-eminently and prior to all other differentiations. If, according to Darwin, in the bilateral structure of animals we may perhaps have a legacy of an aboriginal fusion of two individuals, representing the two incipient sexes, we can see that a primitive hermaphroditism attended by rhythmic fluctuations must have bequeathed a strong tendency towards symmetry and equipoise. Given this strong tendency, which is a factor of the greatest teleological importance, it becomes evident that the exaggeration of the "constitutional bias" of sex, with resulting antithetic development, must be classed among phenomena of the pathological order rather than be treated as of normal significance.

The very stability of an organism's sexual arrangement, just as that of its physiological and morphological balance, is thus again seen to have its solid foundations in primordially fixed conditions.

§ 7. *Progressive "Degeneration"*

As regards the reduction of one kind of sexual apparatus, purporting unisexuality, it is clear that we are dealing with a case of progressive "degeneration," which must be well distinguished from, and which indeed is the opposite of, parasitic degeneration.

Significantly, we are told that often it takes place "when the sexual organs have attained *a very high* *degree of differentiation*," and we shall surely be right in considering the reduction as an "elimination," only such portions being extruded as are no longer compatible with the better status of the species. It would indeed be more correct and less confusing to speak of elimination (teleological adjustment) rather than of a paradoxical progressive "degeneration" in such cases.

The separated sexes can now the better perfect their functions; there is no real loss by the extrusion, for there is no reduction of status. Nor is there need of physiological and structural antithesis, although it now devolves upon separate individuals to preserve intact the separated sexes. The term "degeneration"[1] therefore is, strictly speaking, not admissible in such cases, and only involves logomachy.

§ 8. *Imaginary "a priori" Grounds for Female Preponderance*

As regards the alleged "normal" preponderance of the female type, we can now again refer it to the same pathological causes to which we attributed the reversion in hermaphroditism, and to which we have previously imputed antithesis of size and of numbers. Where it does exist it is only a very common abnormality, representing part of the nemesis of parasitic reproduction—life checked in the matter of progress as in that of environment. The alleged "*a priori* physiological grounds" for female preponderance are imaginary.

---

[1] I accept—though with special emphasis of the teleologically important factors of response and of work—Sir E. Ray Lankester's definitions: "It is only when the total result of the elaboration of some organs, and the degeneration of others, is such as to leave the whole animal in a *lower* condition, that is, fitted to less complex action and reaction in regard to its surroundings, than was the ancestral form, with which we are comparing it (either actually or in imagination), that we speak of that animal as an instance of degeneration." . . . "In degeneration there is *suppression* of form, corresponding to the cessation of work." The view I am advocating, that antithetic developments are symptomatic of degeneration, will, on due investigation, be found to stand the tests here adduced.

The frequent association of hermaphroditism with degenerate reproduction or parthenogenesis in allied forms also lends support to my contentions, and emphasises the transient character of the hermaphroditic stage and its great liability to degeneracy.

I shall presently treat of parthenogenesis, and we shall encounter the same striking universality of cause and effect in its vicissitudes as in those of hermaphroditism.

SUMMARY

It is necessary to discriminate between primitive and pathological hermaphroditism.

Hermaphroditism is commonly connected with parasitism and pædogenesis. The whole phenomenon — including its frequent association with parthenogenesis—strikingly exhibits the usual gradations of degeneracy in related species.

A "stimulating nutrition" is acknowledged to favour the retention of double sexuality, and, moreover, to aggravate it by abrogating natural periodicity and inducing self-fertilisation.

As long as hermaphroditism allows of regular cross-fertilisation, recovery and expansion are possible. The decrease of dichogamy is a striking instance of retributive limitation resulting from dysteleological habits.

A "surplus of material" and sluggishness are acknowledged as the condition of hermaphroditism. Associations with more or less intense parasitic habits are too frequent and striking to have escaped notice.

The history of hermaphroditism, just as that of the origin of animal bilateral structure, strongly supports the view which regards all antithetic development as abnormal and pathological.

The reduction of one kind of sexual apparatus leading to unisexuality constitutes a case of elimination on progressive lines which must be clearly distinguished from parasitic degeneration.

"Constitutional bias of sex," "male katabolism," and *a priori* grounds for female preponderance must be rejected; they fail to explain the pathology of antithetic developments.

CHAPTER III

EFFECTS OF OVER-NUTRITION ON SEXUAL ELEMENTS

> "Any new set of conditions occurring to an animal which render its food and safety very easily attained, seem to lead as a rule to degeneration."—Sir E. RAY LANKESTER.

§ 1. Unicellular Animals.
§ 2. Protozoan Deathlessness.
§ 3. The Real Road to Immortality.
§ 4. Early Separation of Sex-Cells.
§ 5. Normal Differentiation between Somatic and Reproductive Cells.
§ 6. *Chironomus* and Antithesis of Cell-Developments.
§ 7. Incongruities regarding Heredity.
§ 8. Continuity of Germ-Cells abandoned.
§ 9. Alleged Metabolic Stages in Growth of Ovum.
§ 10. Essential Parts of Egg-Cell always Small.
§ 11. Antithesis due to Extrinsic Additions.
§ 12. Diagnosis of Ovum Segmentation.
§ 13. Composite Ova-Embryonic Depredation.
§ 14. Definite Requirements of Fertilisation.
§ 15. Polar Bodies.
§ 16. Contrast between Ovum and Sperm.
§ 17. Vitality of Sperm.
§ 18. Resemblances between Spermatogenesis and Ovum Segmentation.
§ 19. Elimination of Inequalities desired by Nature.

UNDER the above heading we will consider portions of the three chapters in the *Evolution of Sex* on "The Ultimate Sex-Elements (General and Historical)," "The Egg-Cell or Ovum," "The Male-Cell or Spermatozoon."

§ 1. *Unicellular Animals*

We learn that "the simplest organisms leave off where the higher plants and animals begin, *i.e.* as unit masses of living matter. They correspond, in fact, to the reproductive cells of higher animals, and may be called, according to their predominant character, protova and protosperms. A fertilised ovum, as we have seen, proceeds by division to form a 'body'; the Protozoon remains, with few exceptions, a single cell, in which there is obviously no distinction between reproductive elements and entire organism."

"The ordinary Protozoon is a single cell, and forms no body. It divides indeed, and multiplies accordingly, but the products of division go asunder, whereas in the segmentation of the ovum they remain connected. In most Protozoa, there is continual self-recuperation; in most, division occurs without any loss; in most, there is no distinction between parent and offspring; in most, as there is no body, there is no death. Thus it is that, with one weighty caution to be afterwards noted, it seems justifiable to speak with Weismann and others of the 'immortality of the Protozoa.' In a certain sense too, as we shall see, it is justifiable to speak of the immortality of the reproductive cells in higher animals. The body dies, but the reproductive cells escape, before its death, to live on, as new organisms, enclosing new sets of reproductive cells. Again there is similarity between the Protozoa and the reproductive cells."

The question at once arises as to whether this interesting correspondence between the unicellular organism and the reproductive cells of higher animals may not here be carried too far. And, indeed, a little further on it is granted that "if we only knew, they probably differ widely from them in those intricacies of nuclear structure of which we only see the surface."

The ordinary Protozoon may not form a body, but its multiplications must have been the result of some union; there must be subtle differentiations of its constituent elements, which, though too infinitesimal to be detected by the microscope, must correspond to the homologous sexual elements in higher types.

It was at first held that the Protozoa could do entirely without sexual union, a contention which had to be surrendered, however. "Balbiani's view (asserting this fact) was for long scouted, and yet, with renewed observation, naturalists have now come back to his conclusion."

Nor can the alleged self-recuperating condition and vaunted immortality of the Protozoa in the least excite our admiration for these prodigies of modern biologists—some of whom would fain claim to have discovered the road to immortality by degeneration along Protozoon lines.

§ 2. *Protozoan Deathlessness*

It is clear that the extreme primitiveness of the Protozoon's life-processes defies a great deal of scientific analysis, most incipient stages being entirely outside our present means of observation.

Geddes and Thomson, in the chapter under review (No. VII.) claim to speak of "sexual developments" in terms of the changes in the protoplasm, a claim hardly justified, however, when we find them reiterating such platitudes as the deathlessness of most Protozoa.

Is it not feasible that in those lowest stages of the animal world the potential changes in the protoplasm, though invisible, are of the same nature as those taking place in more complex structures? Evolution implies continuity and uniformity; in higher forms it is only a question of piling more pillars and arches on the original protoplasmic foundations.

The multiplication of Protozoa, on the view that I am here advocating, must be regarded as the result of intra-cellular sexual unions—a kind of self-fertilisation which in the previous chapter has been shown to be due to primitiveness or degeneracy. After multiplication, I maintain, death occurs; that is to say, rearrangements equivalent to death are taking place concurrently with reproduction, the metamorphosis being simpler in kind than those usually witnessed, yet no more comprehended in its subtlest components than any other. The synthesis for once seems easy to certain writers. Nothing disappears, there is no need for a burial. This is especially striking to some modern "authorities" on life, and, hence, it is alleged that the individual, instead of continuing a single life, now leads a double life, and has thus "virtually" immortalised itself. "*Sic itur ad astra.*"

But, does there, strictly and scientifically speaking, anything different go on in the metamorphoses of higher forms? Is there not the same circle of life, only appearing a little more complicated? Is there any real loss of life although a considerable body may have to be buried? "Virtually," I maintain that there is not. "*Nec morti esse locum.*"

§ 3. *The Real Road to Immortality*

As soon as we rise a little in the scale of Protozoa, we find it verified that this alleged difference of mortality is only imaginary, and entirely unfounded.

"But in some of the loose colonies (*e.g. Volvox*) we see the beginning of the change which introduced death as a constant phenomenon. The cell, which starts one of these colonies, divides; the products of division, instead of going apart as usual, remain connected; a loose body of many cells is thus formed. In this cluster of cells, certain elements are in turn set apart and eventually adrift, as reproductive cells. They start new colonies, and thus we are introduced to what is constant in higher animals. The only marked differences are: (*a*) that the body of the Metazoon is more than a loose colony of cells; (*b*) that reproductive elements are usually liberated from some definite region or organ; and (*c*) that they are more markedly differentiated as male and female cells."

It is chiefly among the sluggish and highly parasitic Protozoa, it appears, that we must again look for our prodigies, where there is such over-nutrition as to startle even death!—which cannot surprise us very much, seeing that for all these thousand years the identical cause, *i.e.* over-nutrition, has puzzled all eminent "authorities." The "hunger" and consequent retributive curtailment of life in their case is so great that—given the general primitiveness of conditions—the old protoplasmic body is, as I shall demonstrate later on, instantaneously and unrelentingly devoured immediately the new monsters are formed. Death is cheated out of a burial! But who can say that it is in reality robbed of its terrors? The reproductive nemesis in this instance is such that sexual union is practically equivalent to, and coalesces with, instant disintegration and absorption of the parental form by the young. It is only a more exaggerated case of *Gyrodactylus elegans* among the Trematoda—an extensive order of parasitic worms—where the daughter at her birth is ready to give birth to another daughter. To what degree the same life that went to form the parent Protozoon lives on in its division-products, is finally a question for psychology to decide.

Truly, "human science is uncertain guess."

In the *Volvox* and kindred types, on the other hand, a real prolongation of life—a tiny increase on the road to immortality—is purchased by greater relative activity, *i.e.* by the raising of potential.

§ 4. *Early Separation of Sex-Cells*

Coming now to consider the "early separation of sex-cells," we meet again with an example of accelerated development, with reproductive nemesis through precocious disintegrations necessitated by over-nutrition, by infeeding and sluggish habits.

The differentiation between "body" cells and reproductive cells which naturally exists, in many cases, is here abnormally exaggerated.

It is now clear that habits and general circumstances of life must to a great extent condition the various destinies of the reproductive cells, as they must also largely determine the period of separation. It follows that necessities of various kinds enter as components into a system, the resultant of which goes to determine the new organism. Even the factor of time is thus pressed into the synthesis, for, as we have already seen, when through a dysteleological mode of life potential is endangered, precocious separation spelling curtailment of adult life is indicated in the interests of stability and as a safeguard to prevent too great a deterioration of the species.

The insulation of reproductive cells, so far as it goes, is no doubt tantamount to a protection against disturbing external influences, and is a phenomenon of the same order as the care exhibited everywhere by nature to guard and protect progeny; for these isolated sex-elements are the subtle recipients of all that goes to the maintenance of specific potential and increase of the wealth of the species. They are the preservers of its traditions, and in their history they mirror the fluctuations of racial life. If degeneration begins to afflict a species, it is necessary to prevent these teleologically important cells from being directly affected, that sacrifices in other directions should be made in order to maintain equilibrium. Thus the individual existence is curbed in the matter of time. Its portion of immortality is reduced lest the racial life should suffer from its immorality (if this play on words may be forgiven), *i.e.* lest adult degeneracy should have disastrous reactions on the reproductive life. In this connection, however, it is again curious to note how our biologists show such marked bias as they constantly do in favour of exotic and parasitic types in order to demonstrate their theories.

Momentous generalisations are thus to be gleaned from observations concerning *Chironomus*, leeches, aberrant worms, *Cladocera*, water-fleas, *et hoc genus omne.*[1]

§ 5. *Normal Differentiation between Somatic and Reproductive Cells*

Normally, there can be little doubt but that the differentiation of somatic and reproductive cells is merely incidental, and only just in keeping with the exigencies of the required division of labour.

We must remember the extreme adaptability and retentive capacity of protoplasm, and the conventional nature of our distinctions between simple and complex bodies.

As soon as we enter the regions of the more normal life, the pronounced antithesis of germ-cell and somatic cell disappears. I agree with Professor Hertwig's view that every cell is potentially a germ-cell. He denies the existence of a cardinal distinction between the germ-plasm and the plasm that goes to form the individual body. He observes that *in the higher plants* there is a widespread occurrence of tissues which have the power of reproduction—though these tissues belong to the individual body of the plant, and are definitely distinct from the special reproductive tissues which contain the "germ-plasm" of Weismann.

---

[1] "The object upon which the intimate phenomena of fertilisation have been most studied is the ovum of the thread-worm (*Ascaris megalocephala*) which infests the horse."

§ 6. *Chironomus and Antithesis of Cell-Developments*

We are now introduced to the famous case of the fly *Chironomus*, with its pædogenetic isolation of the reproductive cells—which is instanced in support of the Weismannian theory regarding non-transmission of "acquired characters," and round which the storm of controversy still rages.

"In the case of a well-known fly, *Chironomus*, Professor Balbiani, unprejudiced by any theory of heredity, observed the following facts:—Before the segmentation of the egg had at all advanced, before what embryologists call the blastoderm was more than incipient, two cells were observed to be set apart externally (these had nothing whatever to do with the polar globules seen in most ova at maturation). The development proceeded apace, but the isolated cells took no share; they may be presumed to have retained intact the characters which they received when first divided off from the ovum. At a certain stage, however, the insulated cells sank inwards, took up an internal position, became the rudiments of the reproductive organs. Here, then, at an early stage, before differentiation is marked, the reproductive cells are set apart. They must therefore preserve much of the character of the parent ovum, and hand on the tradition intact by continuous cell-division to the next generation. In other words, in the preceding case, at a very early stage in the embryo, the future reproductive cells are distinguishable and separable from the body-forming cells. The latter develop in manifold variety, into skin and nerve, muscle and blood, gut and gland; they differentiate, and lose almost all protoplasmic likeness to the mother ovum. But the reproductive cells are set apart; they take no share in the differentiation, but remain virtually unchanged, and continue unaltered the protoplasmic tradition of the original ovum. After a while, they, or their division-products rather, will be liberated as reproductive cells. These in a sense will be continuous with the parental germ. Their protoplasm will be more or less identical. The original ovum has certain characteristics, *a*, *b*, *c*; it divides, and all its cells must at first more or less share these characteristics; the body-cells lose them, the insulated reproductive cells must retain them. The ovum of the next generation has thus also the characteristics *a*, *b*, *c*, and must therefore produce an organism essentially like the parent.

"*An early isolation of the reproductive* cells, though never so striking as in *Chironomus*, has been observed in many cases—*e.g.* in other insects, in the *aberrant* worm-type *Sagitta*, in leeches, in thread-worms or *Nematodes*, in some Polyzoa, in some small crustaceans known as *Cladocera*, in the water-flea *Moina*, and in some spiders (Phalangidæ), and probably in other cases. *As the series is ascended*, the reproductive *organs are later in making their appearance*, or at least they are only detected at a later stage; and it must also be pointed out that, in cases of alternation of generations, an entire asexual generation, or more than one, may intervene between one ovum and another."

Here we have striking examples of curtailment of life resulting from perpetual infeeding.

The contrasts provided by *Chironomus* and its confederates in the physiological sense are of the antithetic order, and present no adequate comparison whatsoever with the developments at the higher and more normal stages of life.

Some biologists, however, have hastily concluded that, given this (abnormal) antithesis of cell-development, bodily and external influences are practically of no importance in heredity, even in the case of the highest animals, that no individually acquired characters, either plus or minus, can be transmitted, and that the body indeed is eternally predetermined by the ancestral reproductive cell. Such a view mirrors a geometrical progression of confusion, and indeed does not accord with the hypothesis of evolution, as Herbert Spencer justly pointed out. It is mainly due to misconceptions respecting the rationale of antithetic developments and concerning the significance of ancestral dynamics.

Weismann's fatal theory, although running counter to a vast number of observed facts, is variously supported by a series of pure hypotheses involving the hereditary outlook in a veritable maze; and we can see that this parlous state of affairs was bound to arise in the absence of all understanding of normal developments.

§ 7. *Incongruities regarding Heredity*

It would lead too far to try and expose the many verbal confusions and sophistries sailing variously under the flags of "acquired characters," "modifications," and "hereditary characters."

Practical men (breeders) are admittedly opposed to Weismann's speculations; so are Haeckel, Spencer, and many others. Spencer refused to accept the contrast between body-cells and germ-cells as expressing a fact.

As regards the "Apartness of the Germ-cells," Professor Thomson in his *Heredity* opines that:

"If the germ-plasm or the material basis of inheritance be something relatively apart from the body, and from its everyday metabolism, something often segregated at a very early stage in development, there is a presumption against its being readily affected in a specific manner by detailed exogenous changes wrought on the structure of the body."

But I contend that this alleged apartness from the body's "everyday metabolism" is but a case of antithesis, of pædogenetic development primarily determined by the organism's illegitimate "everyday metabolism," as we have found all parasitic and accelerated developments most accentedly to be. Where is any evidence of an apartness amounting to a striking antithesis to be met with other than in parasitic types?

But by a vicious circle of *post hoc ergo propter hoc* arguments the true case is inverted, and it is made out that, seeing this early apartness of germ-cells in *Chironomus* and its like, mere exogenous changes affecting the "body" matter very little from the hereditary point of view. The door is thus opened for all manner of loose thinking and practical abuse in the conduct of life. If any cause that affects the body is shown likewise to affect the germ-cells, it is declared that "nobody has ever denied that the germ-plasm is capable of being affected *along with* the body [whatever this may mean!] *by a deeply saturating influence*," but that "changes in the germ-cells, along with changes in the body, *are not relevant*."

Are we to understand that there is no normal and well-defined connection between nutrition and sex? But perhaps these matters have not been sufficiently studied, and pending their exposition our scholars are drifting on a sea of merely verbal distinctions.

It is delightfully simple, on this verbal *post hoc* method, to set down everything that can be shown to affect the germ-cells as being irrelevant, because along with its effect there have been changes in the body-cells; as if normally any cause could affect the protected germ-cells without at the same time affecting the more exposed body-cells. Whatever changes in the germ-cells there may be *not* concurrent nor even commensurate and harmonious with those in the body-cells, we must set down to accelerated growth, representing an antithesis between nutrition and sex.

In order to make his position very clear—to express accurately though figuratively what Weismannians include in their programme and what is there lacking—Professor Thomson states that "we have no warrant for believing that the modification of a part re-echoes in a definite specific way through the organism until even the penetralia of the germ-cells reverberate."

Weismann and Thomson make some concessions, vaguely admitting the influence of nutrition; but it is, of course, true that every function of the body has a definite metabolic value.

Thus, in the latter's *Heredity* (p. 203) it is pointed out:—

"Again, however, we must remember that the blood, or lymph, or other body-fluids form *a common medium for all the parts of the animal*, gonads included; the results of changes in nutrition may saturate throughout the body and affect the germ-cells *inter alia*. The nervous system makes the whole organism *one in a very real sense*; in plants there are often intercellular bridges of protoplasm binding cell to cell, and this is true in not a few cases among animals. Moreover, there are *subtle, dimly understood correlations* between the reproductive organs and the rest of the system. If changes in the reproductive organs can effect changes in remote parts, such as the larynx and the mammary glands, why may not there be reciprocal influences? In short, the *organism is a unity*, and to divide it up, in any hard-and-fast way, into soma and germ-cells may land us in the same fallacy as parcelling the mind into separate faculties.

"It must be admitted, therefore, that it is quite erroneous to think of the germ-cells as if they led a charmed life, uninfluenced by any of the accidents and incidents in the daily life of the body which is their bearer. But no one believes this, Weismann least of all, for he finds *the chief source of germinal variations* in the stimuli exerted on the germ-plasm by the *oscillating nutritive changes in the body*."[1]

§ 8. *Continuity of Germ-Cells abandoned*

And now we are told in the *Evolution of Sex* that: "In the present state of our knowledge we can only speak of the continuity of the reproductive *cells, in exceptional or rather in a small minority of cases.* Alike in the higher vertebrates and the lowly hydroids, the reproductive cells may appear late. After the differentiation of the vertebrate embryo has progressed far, or the life of the polyps continued for long, the germ-cells make their appearance; and though we know, of course, that they are descendants of the original ovum, yet we must allow, with Weismann, that in the form of special cells *they are now for the first time to be detected.* Therefore, Weismann says, 'a continuity of *germ-cells* is now for the most part no longer demonstrable.'"

---

[1] Weismann, however, states that no mathematical proofs of those germinal processes exist, "since we cannot penetrate into the play of forces of the passive and active nutritional fluctuations and their causes" (*Die Selektionstheorie*, p. 29). This play of nutritional forces in the germinal regions appears to him entirely a matter of chance ("Zufällige Nahrungsströme"). He scarcely seems to allow for a connection between embryonic nutrition and adult habits. Failing this and the further recognition of the teleological significance of nutrition generally, his reasoning is throughout guided by the old narrow conceptions of "usefulness."

In other words, that is, in terms of my contention, a glaring antithesis of nutrition and sex, though very frequent, is by no means normal.

But Weismann has substituted the theory of the germ-plasm for that of the continuity of the germ-cells.

The continuity, according to him, "depends upon the continuance and unchanged persistence of a minimal quantity of the original *germ-plasma*"—a highly hypothetical and imponderable essence.

§ 9. *Alleged Metabolic Stages in Growth of Ovum*

When we come to study the growth of the ovum, we meet again with a proneness on the part of our biologists to single out abnormal instances and abnormal conditions in order to demonstrate its alleged extreme anabolic nature.

We are told: "When the ovum is very young, it very generally presents the features of an amœboid cell. In some cases this phase persists for a longer time, as in the ovum of hydra, which in all essentials is comparable to an amœba. Even in the simplest animals, however, the amœboid phase constantly shows a tendency to pass into greater quiescence, to become in fact more or less encysted. So is it with ova, which, though at first often resembling various forms of amœboid cells, tend more or less quickly to pass into the encysted phase. The protoplasm no longer flows out in irregular ever-changing processes, but is gathered up into a sphere, rounded off, and surrounded by a more or less definite envelope. This transition from a state of relative equilibrium between activity and passivity, to one in which passivity undoubtedly predominates, *is associated with an increase of nutriment and reserve products.* The ovum feeds, becomes heavy with stored capital, becomes less active, and more encysted in consequence."

It is clear that we are here dealing with an exaggeration. Physiologically, the comparison with the amœba is not exact, and with the higher types in especial we must conceive of the ova as being charged with far greater potentialities than at the hydra stage. The equilibria and polarities are quite different.

It appears in no wise warranted to generalise as to the normal habitat of the ovum from a few exotic cases; rather must we infer from the degree of passivity and inertness on the part of the ovum the backwardness of the parent.

In describing an ovum heavy with stored capital and approaching the encysted stage, Geddes and Thomson are in reality describing, in my view, the excrescences of a nutritive diathesis.

§ 10. *Essential Parts of Egg-Cell always Small*

The facts, however, are that: "The essential part of an egg-cell is always small, though even in this there are great differences. The nucleus, for instance, in the large eggs of amphibians, reptiles, and birds may be detected with the unaided eye; while in other cases such as sponges the entire ovum is very minute. Yet everyone knows that eggs vary enormously in size."

"*The eggs of whales are 'not larger than fern-seed,' and the same is true for most mammals except the very lowest.*"

One cannot help remarking in this connection that the smallness of the mammalian ova may be typical of a relative rectitude of assimilation—potential rather than mere size being the desideratum. However this may be, the phenomena at the higher stages of life must be taken into account in a study of the laws of sex quite as much as those characterising low and aberrant types.

§ 11. *Antithesis due to Extrinsic Additions*

Indeed, we learn that: "The differences in size, when very striking, are due not so much to any marked disproportion in the essential parts of the ova, but to certain extrinsic additions. The most important of these is the yolk, which serves as nutritive capital for the embryo or young animal."

"The egg has its nutritive capital increased in three different ways:—(*a*) Very generally it feeds on the nutritive elements in the general lymph or vascular fluid of the body. (*b*) At the same time, or in another case, it avails itself of the débris of surrounding cells. In many instances, *e.g.* in the minute ovary of hydra, or in the ovarian tubes of insects, the ovum is but the surviving competitor among a crowd of surrounding cells, which to start with were all potential ova. (*c*) In the third place, and this is the rarest form, the egg-cell acquires a store of food-material from a special yolk-gland, as in many of the lower 'worms.' But we have already pointed out that this yolk-gland is usually interpreted as a degenerate portion of the essential organ. The yolk, gained in the above ways, is more or less readily distinguished from what is often called the formative protoplasm. Out of the latter the embryo is built up, while the yolk has for the most part *only a secondary and nutritive rôle.*"

Germinal antithesis we thus find to be due to "extrinsic additions" under the same rationale[1] as that underlying anatomical antithesis.

---

[1] The struggle between germ-cells, according to Geddes and Thomson, is an often forgotten chapter in the struggle for existence. But I maintain that it represents the dire results of habitual and intense infeeding. It implies a type of wastrels which do not contribute towards the production of food, and must therefore ultimately find themselves left without any. As acceleration of life-processes

The gradations of "germinal selection," as evinced by these various vicissitudes of embryonic feeding, are proportionate to the degree of dysteleological behaviour on the part of the respective animals.

§ 12. *Diagnosis of Ovum Segmentation*

The same gradations, under the same direct proportions, again obtain in degrees of ovum segmentation.

"The possibility of distinguishing between formative protoplasm and the nutritive material depends on the quantity of the latter that is present, and on the way in which it is disposed. (*a*) When there is not much of it, as in the small ova of mammals and many invertebrates, the yolk-material is diffusely distributed. Then the ovum undergoes complete segmentation. (*b*) In the frog's ovum, on the other hand, there is a large proportion of yolk, which has especially accumulated in the lower hemisphere of the cell, while the darker half includes the truly formative protoplasm. In this case, too, the egg divides as a whole, but the divisions go on much more rapidly in the upper hemisphere, and it is there that the embryo is really formed. (*c*) A distinct mode of yolk-arrangement occurs in arthropods (crustaceans, insects, etc.), where the centre, not a pole, of the ovum is occupied by the nutritive material. In

---

and redundancy are part and parcel of such degeneracy, we can easily perceive how it must involve "struggle" from the very embryonic plane onward. To such phases of life must we apply Sir E. Ray Lankester's dictum that: "Accordingly, there is necessarily a struggle for existence—a struggle among all those born for the possession of the small quantum of food" (*Degeneration*).

this case the formative protoplasm divides round about the nutrient core. (*d*) In the majority of fishes, in reptiles, and in birds, the eggs show a much more marked polar accumulation of yolk. On the top of a large mass of nutritive material, the specifically lighter formative protoplasm lies like a tiny drop, and in those cases *the division of the ovum is very partial*—that is, it is mainly restricted to the upper formative region. It is thus to be noted that the quantity of yolk present, and its diffuse, polar, or central arrangement, *are associated with striking differences in the degree and symmetry of the segmentation.*"

I have already referred to the occurrence of the yolk-glands (Vitellaria)—supposed to represent degenerate portions of the ovary—in grave cases of parasitism, and I have traced this "misère" to the surfeiting habits of the respective animals.

The "secondary rôle" of the yolk-material is closely associated with the physiological nemesis which has occurred in the case of this group. In the vicissitudes of segmentation we again encounter proof of the fact that surfeit has a degenerative influence upon sex and morphology generally, or, in other words, that with increasing parasitism a modicum of true symmetrical breeding (the reproductive requisite) can only be retained at the cost of dire reproductive sacrifices.

Nothing could be more significant, again, from the diagnostic point of view than the fact that "the quantity of yolk present, and its diffuse, polar, or central arrangement, are associated with striking differences in the degree and symmetry of the segmentation."

§ 13. *Composite Ova-Embryonic Depredation*

An interesting case of a reproductive "misère" in parasitism is related in the case of composite ova.

"We have emphasised the fact that the ovum must be regarded as a single cell. To this a definite but pedantic objection has been raised. In some parasitic flat-worms there occur what have been called compound ova. A minute single cell arises, as usual, in the ovary, but in the course of its somewhat intricate history this becomes associated with several nutrient cells derived from the yolk-gland. These surround the original ovum, so that the whole now consists of several cells. But it must be noticed that only the central cell—the ovum proper—is fertilised, and that it contains all the formative protoplasm. Those that surround it are wholly nutritive; they eventually break up, and are absorbed.

"In other cases, especially in insects, the ovum grows rich at the expense of neighbouring cells, which are sacrificed to its nutritive equipment. But it is evident enough that a cell remains a cell, however many of its neighbours it may happen to absorb."

Parental parasitism, involving as it does the need of a surfeiting food-supply projected into the very embryonic stages, thus presents a case of perverted racial dynamics. The parasitic trait has to be at a very early stage stamped upon the young if they are to inherit the family habits, if they are to "survive" at all; and thus the ovum already may frequently be characterised by a propensity to prey upon its neighbours. We have seen in previous chapters how in the same way individual organs are frequently characterised by the predatory habit, robbing adjacent parts of their nourishment. There is scarcely a teleological mode of seed-production in these cases; the majority of seeds are precluded from survival to any useful purpose, and have sunk to the level of mere automata in the losing game of infeeding.[1]

The grave retributive aspect of the widespread disorganisations parasitism gives rise to cannot be sufficiently emphasised. With every step it undermines the fundamental principles upon which alone a species and a social organisation may be successfully reared.

At the same time, the deeper we penetrate into the mysteries of sexual processes, the more apparent becomes the fundamental significance of symmetrical normal developments.

Herbert Spencer very truly remarked that "the saying that beauty is but skin-deep, is but a skin-deep saying."

§ 14. *Definite Requirements of Fertilisation*

A justification of the views here propounded respecting ulterior needs of symmetry and definite proportions again comes out in the following passages:—

---

[1] "And even after the eggs begin to develop there is often *elimination apart from enemies*" (italics mine), we are told in the revised edition of the *Evolution of Sex*.

"One marvellous fact, showing the closeness of union in fertilisation, may be briefly re-emphasised. In the double nucleus formed from the union of the male and female nuclei, Van Beneden, Carnoy, and others have shown that *both constituents have an equal share.* 'The one half is purely male, the other purely female, and this is true not only for *Ascaris* (by Van Beneden) and other thread-worms (by Carnoy), but for representatives of other worm-types, cœlenterates, echinoderms, molluscs, and tunicates.' In division to form daughter-cells (ix., x.), half of each set of constituents goes to either cell, and the dualism is kept up. Furthermore, though hardly yet quite certain, it is most probable that of the four chromatin loops observed in the division figure of a daughter-cell, two are derived from the male parent, and two from the female."

"The importance of this fact," Geddes and Thomson continue, "in relation to the influence of both parents upon the offspring, is very obvious."

All this shows that symmetry and equality are required in sex, rather than pronounced antitheses. Even parasitic generation, with all the prodigious oddities it gives rise to, has in these initial and fundamental respects no alternative, and meets with its *ne plus ultra.* The distorted balance of nature must be readjusted somewhere.

No longer will parasitic "economies" and expedients avail. The parasite will have tardily to make the greatest reproductive sacrifices by way of restoring the required equilibria, unless the species is to become extinct.

In such wise may we also understand how "sexual reproduction is a remedy against the operation of injurious variations," which, we have already seen, is the view of Hatschek.

If frequently injurious influences cannot be avoided, it is now also clear that it is only through inner resistance that they can be adequately met. Woe to a species that yields to parasitic temptations!

It is inadequate to say that sexual reproduction constitutes a safeguard; it is only the visible outer efflorescence of an inner power, and it is on this latter that everything depends.

Again, to state that "we can readily imagine that the excess of some particular line of anabolic or katabolic differentiation may be neutralised through fertilisation," is as manifestly to underrate the import of metabolic extremes as it fails to grasp the rationale of reproduction.

§ 15. *Polar Bodies*

When we now turn to the "maturation of the ovum," we come to the interesting phenomena known as "polar bodies."

"When the egg-cell has attained its mature size, a more or less *enigmatical occurrence* takes place. The nucleus, hitherto generally central, moves to the pole, alters considerably in its structure, and divides. A minute cell, with half of the nucleus and a small amount of protoplasm, is given off. Not long after, the nucleus remaining within the ovum repeats the process, and another tiny cell is expelled. This process, which the majority of investigators regard as one of normal cell-division or cell-budding, is known as the extrusion of the polar globules. Of general, and probably of universal, occurrence, it has been but rarely observed in fishes and amphibians, and not as yet demonstrated in reptiles or birds. It was for long thought to be absent in arthropods, but the researches of Weismann, Blochmann, and others have shown that this is not the case. An interesting peculiarity, which we shall afterwards notice, has been demonstrated by Weismann in regard to parthenogenetic ova. There is considerable diversity as to the exact time at which the extrusion occurs; generally, however, it precedes the entrance of the fertilising sperm. The minute extruded cells never have any history, though they occasionally linger for a considerable time on the outskirts of the ovum. As an exception, they have been seen themselves to divide, and, with equal rarity, a misguided spermatozoon has been observed to penetrate them. Usually, however, they simply dwindle away. The remaining female nucleus of the ovum is now ready to unite with the male nucleus of the spermatozoon. By the twofold division just described it has been considerably reduced in size, though not a whit in complexity, or in the number of its chromatin elements."

The theories as regards the meaning of the process are very divergent. Some interpret it as an abnormal cell-division; some say it is normal; others again speak of a kind of "excretion" of the ovum or a "rejuvenescence" of the nucleus.

"According to some, the egg-cell is in a sense hermaphrodite, and the polar-globule formation is an extrusion of the male element."

"According to Minot," in the cells proper, both sexes are potentially present; to produce sexual elements the cell divides into its parts; in the case of the egg-cell, the male polar globules are cast off, leaving the female ovum. "In parthenogenetic ova, he supposes that enough male element is retained, since only one polar globule appears to be formed."

"A very different view—morphological rather than physiological—has been maintained by Bütschli, Whitman, and others. The formation of polar globules is an atavistic reminiscence of the primitive parthenogenesis. Just as the mother sperm-cell or spermatogonium, which corresponds in the male to the ovum in the female, divides up into what form spermatozoa, so the ovum retains a slight power of division. Yet parthenogenetic ova, so far as polar globules are concerned, show this least, nor can we well conceive an atavism so universally present without some important physiological necessity behind it. To Bütschli's view, however, such an authority as Hertwig inclines, and Boveri likewise interprets the polar globes as 'abortive ova.'"

Weismann speaks of the ovogenetic substance eventually forming *an encumbrance which requires extrusion.*

Geddes and Thomson think that "the ovum, like any other cell, tends to divide or bud at the limit of growth, a view in no way inconsistent with regarding the process as an extrusion of male elements."

There is thus a formidable array of speculation and of physiological and morphological explication associated with these polar bodies.

As regards the first views mentioned, we can well see a necessity for eliminating material abnormally accumulated arising from the stringency of reproduction requirements previously alluded to.

From my point of view, these processes would have been preceded by abnormal intra-cellular unions. Polar bodies may thus well represent the abortive results of embryonic (illegitimate) self-fertilisations; the direct physiological necessity for the extrusion lying in the exigencies of reproduction.

The phenomenon would thus constitute a surrender of superfluities, an elimination of encumbrances, which some lower types cannot achieve, but which encumbrance they retain along with general primitiveness.

The retention of the superfluous material is not compatible with increasing powers. It suggests that the reduction illustrates the process of teleological adjustment (elimination).

In the case of parthenogenesis the sexual potential, owing to a nutritive overflow, being entirely diffused, and the embryo of a degenerate organism requiring, moreover, as we have seen, to be maintained in an adequate surfeit, there is no scope for elimination.

The resemblance that the case undoubtedly bears to the disappearance of male elements in parthenogenesis is highly significant from the point of view here propounded as to the underlying causes of the extrusion.

§ 16. *Contrast between Ovum and Sperm*

As regards the contrast between ovum and spermatozoon, we are assured that "the two kinds of cells are just as widely opposed in their general features, as they are fundamentally complementary in their history."

This being the case, we may again conclude that normally their differentiation is limited, and determined by the exigencies of division of labour.

The sperm "is like one of the highly motile Protozoa, like a flagellate infusorian."

But occasionally it exhibits signs of degradation—admittedly in spite of its alleged fundamental katabolic character. "Thus in the thread-worm *Ascaris*, the sperm has a blunt, pear-shaped form, and exhibits slight amœboid movements. In some crustaceans and other arthropods, the cell is even more quiescent, and may exhibit curious forms such as that figured for the crayfish."

Moreover, the conditions under which the germ has to exist—its environment—would seem to determine largely its relative katabolic or anabolic demeanour.

"Zacharias has made some interesting experiments, showing the modifiability of sperms under reagents ;

thus, in a little crustacean (*Polyphemus pediculus*), he first caused the cylindrical sperm to form amœboid processes, and afterwards to replace these by what were to all intents and purposes cilia."

"This is entirely congruent with other experiments and observations on the passage of cells from one phase of the cell-cycle to another."

It all shows that nutritive habits determine the various morphological phases, metamorphoses, and vicissitudes of life, and that nothing is easier than to verify it by observation and experiment.

§ 17. *Vitality of Sperm*

A great feature of the sperm is its frequent persistent vitality. "The spermatozoa received by the queen bee during her single impregnation are for a considerable period—even for three years—used in fertilising successive sets of worker and queen ova. Quite unique, however, is the case of Sir John Lubbock's queen ants, which laid fertile eggs thirteen years after the last sexual union with a male. The spermatozoa had *apparently* persisted all that time."

This assumed persistence of the sperm for thirteen years within the queen certainly appears very hypothetical. It makes so exorbitant a demand on our credulity that we almost feel constrained to look for a different explanation; especially as we were previously assured of the delicate katabolic nature of the male elements.

Now, if we assume the persistence of potential, that is, the exaltation of the physiological status of the female, which fertilisation implies in an organism otherwise largely a nutritive automaton and upheld by extrinsic stimuli, the case would seem to be much simplified.

The queen, by laying eggs generation after generation, mainly draws on the static supports of the tribe ; the slowly exhausting potential having, however, from time to time to be replenished by sexual fertilisation, implying reproductive sacrifices.

It is also worth noting that, as regards the sperms, "the presence of acids has usually a paralysing influence, but alkaline solutions have, on the whole, the opposite result."

§ 18. *Resemblances between Spermatogenesis and Ovum Segmentation*

The comparison of spermatogenesis and ovum segmentation again exhibits striking similarities, showing that the different habits of a species affect male and female elements much in the same way. It is almost proof positive of the contention here made that the metabolic ratio between animal and plant in the greater household of nature, and not that relative to the sexes, is the fundamental determining factor on which the growth and well-being of a race primarily depend.

Sperms and ova under dysteleological conditions of life exhibit exactly analogous discrepancies of segmentation to those which obtain in general anatomical features.

Thus, with partial segmentation in the ovum—I have already referred to the nature of irregular segmentation—there may be cells which can scarcely be said to be "markedly defined off from the yolk." They tend towards amorphism, and the same is true of the corresponding sperm-cells.

§ 19. *Elimination of Inequalities desired by Nature*

Sperm and ovum, normally, in order to become truly complemental, have both to undergo a precisely parallel process, and would seem to be more concerned with rounding off nutritive inequalities and impurities than with any tendencies towards antithesis.

Thus Geddes and Thomson emphasise the homology between "mother-sperm-cell and ovum," and the "striking parallelism between the modes of division of these homologues." Further :—

"Platner has in a remarkable manner demonstrated the unity between the division of the ovum in extruding polar globules and the division of the spermatocytes. In both cases occurs the unique phenomenon of a second nuclear division following on the heels of the first, without the intervention of the usual resting phase."

All this testifies to the correctness of the analysis that I have attempted to set forth.

The important and interesting fact emphasised by Miescher, "that while the sperm is being formed in the Rhine salmon, the animal is fasting," again reveals the same tendency to reduce the nutritive exaggeration in order to provide scope for the higher potential which is sex. The salmon, be it noted, is a most voracious fish, feasting on animal matter. It consumes a huge proportion of crustacean life and shows great "fertility."

SUMMARY

The similarity between unicellular animals and the reproductive cells of higher animals has been exaggerated. Protozoan "deathlessness" is a phenomenon of dissociation.

Early separation of sex-cells is founded on accelerated (parasitic) developments. Likewise the differentiation between somatic and reproductive cells is thus frequently an abnormal (pathological) phenomenon. The general circumstances of life are responsible for the destinies of the reproductive cells, precocious separation being indicated where illegitimate habits increasingly endanger heredity. Contrasting behaviour in soma and germ-cell, where it exists, is an indication of antithetic development.

The phenomena connected with the growth of the ovum are the exact parallels to those of general growth. Germinal antithesis is manifestly due to extrinsic additions, and "germinal selection" is directly proportionate to the degree of dysteleological behaviour.

The degrees of ovum segmentation are likewise determined by a metabolic ratio, and are diagnostically significant.

Parental parasitism involves the need of a surfeiting food-supply, projected into the very embryonic stages to the detriment of racial dynamics. Embryonic depredation exemplifies how parasitic traits are being precociously stamped upon the race. There is under such circumstances little scope for a teleological mode of seed-production. The majority of seeds are precluded from survival to any useful purpose, and frequently sink to the level of mere automata in the losing game of infeeding.

Nuclear developments exhibit the universality of definite requirements. The propagation of parasites in these crucial processes meets with its *ne plus ultra.*

The case of "polar bodies" illustrates the processes of elimination and extrusion in accordance with teleological exigencies.

The vicissitudes of the sperm show that its shape and fate are determined by its history—or rather that of the organism.

Sperms and ova under dysteleological conditions of life exhibit analogous discrepancies of segmentation. Their joint history shows that homologous development and elimination rather than antithesis and plethora are normally required.

CHAPTER IV

MORE ANALYSIS OF SEX

"Multo plures satietas quam fames perdidit viros."

§ 1. Metabolism and the losing Game of Life.
§ 2. Confusions arising from a slippery Basis.
§ 3. "Starving" Males.
§ 4 Recurrent Need of Constant Proportions.
§ 5. Parasitism the real Starving of a Species.
§ 6. Weismann denies dynamical Action in Fertilisation.
§ 7. "Nutritive Wants" an entire Assumption.

§ 1. *Metabolism and the Losing Game of Life*

IN the chapter on the "nature and origin" of sex we learn that the bodies, "as Weismann has so clearly emphasised, are but appendages to this immortal chain of sex-cells," a statement which we can now only read to denote that ancestral dynamics and racial influences in the majority of cases supersede all individualistic response.

We are at the same time introduced to a "cell-cycle." Thus "an infusorian has its encysted chapter, a gregarine its amœboid stage, and a rhizopod may begin as a mobile ciliated spore: for each group, while accenting one phase of the cycle, retains *embryonic reminiscences* of the others."

We also find the interesting recognition of a ciliated animal cell *pathologically* becoming amœboid.

As a cell passes from one phase to another, a student's "rough classification of the Protozoa would be verified in the histology of higher animals, and *would reappear in the study of their diseases.* He would be thus at length in a position to say that, however these three phases were brought about, the forms characteristic of them were of such wide occurrence throughout nature as to justify his restatement of the familiar cell theory in terms of a larger conception, that of the *cell-cycle*; that is to say, from the conception of the cell as a unit mass of living protoplasm, amœboid, encysted, or ciliated, as the case might be. He would come to regard these forms as the predominant phases of a cycle—primeval, certainly, in the history of the organic world, and largely so even in the individual cell."

The wide occurrence of pathological phenomena and their similarities, however, contains no proof that disease is founded in a natural order of things, is *secundum naturam.* The case warrants the inference, however, that Protozoa and kindred types are of a low teleological value.

We are told, as regards income and expenditure of the cell: "The disruptive, or katabolic, or energy-expending set of changes may be obviously greater in one cell than in another, in proportion to the constructive or anabolic processes. Then, we may shortly say that the one cell is more katabolic than the other, or *vice versa* on the opposite supposition. Just as our expenditure and income should balance at the year's end, but may vastly outstrip each other at particular times, so it is with the cell of the body. Income too may continuously preponderate, and we increase in wealth, or similarly in weight, or in anabolism. Conversely, expenditure may preponderate, but business may be prosecuted at a loss; and similarly, we may live on for a while with loss of weight, or in katabolism. This losing game of life is what we call a katabolic habit, tendency, or diathesis; the converse gaining one being, of course, the anabolic habit, temperament, tendency, or diathesis. The words anabolic and katabolic are, of course, new, unfamiliar, and undeniably ugly. Habit and temperament have very vague associations, and tendency sounds metaphysical; diathesis, again, seems no better than the medical equivalent of this. These things the reader must naturally feel; yet the medical man is nowadays quite scientific and definite in speaking of gouty or neurotic diathesis, of bilious habit, strumous tendency, or the like. The metaphysical vagueness is no longer chargeable to him; still less, we trust, to us."

Now, whatever may be the fashionable medical theory of the moment, health must at all times consist of a just balance of functions, and if a cell plays a losing game, this must in the first instance be set down to dysteleological causes.

But if the "katabolic habit" is to be tantamount to this losing game of life, then indeed it will not be difficult by such merely verbal arrangement to prove many an otherwise untenable proposition in terms of anabolism and katabolism.

§ 2. *Confusions arising from a Slippery Basis*

The authors at once proceed to exploit the syllogistic vantage-ground they have thus constructed for the launching of their theories.

"We are now in a position profitably to return to the Protozoa, to the phases of cell-life, and to the sex-elements. After what we have just said, it is evident that there are but three main physiological possibilities,—preponderant anabolism, or predominant katabolism, or an approximate (*i.e.* oscillating) equilibrium between these tendencies. A growing surplus of income, a lavish expenditure of energy, or a compromise in which the cell lives neither far below nor quite up to its income. Great passivity, great activity, or a safe average between these; conservative accumulation, spendthrift liberalism, and a compromise between these. In many different ways, more or less metaphorical, may be expressed the plain and indubitable facts of anabolism and katabolism within the living matter."

But are not at least two of these "physiological possibilities" (in the Protozoon case at any rate) for the most part pathological possibilities?

We are told that in amœboid organisms metabolic extremes are avoided; "there is certainly great amplitude of variation still, but neither anabolism nor katabolism gains the ascendant in any marked degree." Moreover, "young ova are frequently amœboid"; but "*with a copious nutrition* this disappears in varying degrees of encystment."

"Copious nutrition," of course, we are to set down entirely to the "anabolic diathesis."

"Femaleness is anabolic preponderance in reproduction; hence the ovum has necessarily the general character which this 'diathesis' produces in non-reproductive cells; and, similarly, katabolic preponderance stamps its character of active energy upon the spermatozoon as naturally as upon the ciliated cell or the monad."

§ 3. "*Starving*" *Males*

We have seen in previous chapters to what confusion it leads to exaggerate this minor ratio between the sexes, whilst neglecting the all-important ratio of the wider cosmic metabolism.

The male cells are characterised by Rolph as "hungry and starving" (katabolic), and this "has been experimentally confirmed by their powerful attraction to highly nutritive fluids."

Such experiments,[1] I suggest, only testify to the existence of an exaggerated nutritive sensuality which generally afflicts, in but slightly varying degree, both male and female and which, carried to an extreme, curses the species as such.

It was known already in ancient times that "*multo*

---

[1] *Observations provoquées*, as Claude Bernard probably would have said.

plures satietas quam fames perdidit viros," and this hunger can hardly be termed a healthy need. Is it not that frequently the "anabolic" and "bloated" female evinces a morbid craving for the flesh of her pigmy male? Indeed, the cannibalistic "hunger' of the "anabolic" female in these instances far surpasses the attraction of the "starving" "katabolic" male by highly nutritive fluids. Is it not plain that we are dealing here with morbid cravings?

The metaphor of the "hungry and starving" male cell indeed lends pathological significance (not normally chargeable) to the process of fertilisation. I should be the last to deny, however, that this has a certain foundation in fact; for in a great majority of cases reproduction is pathologically indicated. The effect of infeeding, arthritism, and parasitism in projecting precocious and disaggregating reproductive propensities —along the lines of the "losing game" of life—upon the young (pathology in course of transmission) has already been emphasised. Suffice it here to add that, as Professor Pearson has pointed out, with tuberculous stocks among men, the pathological conditions do not tend to reduce fertility, but that probably their fertility is greater than that of other classes.

§ 4. *Recurrent Need of Constant Proportions*

As regards fertilisation, it is interesting to learn from the *Evolution of Sex* that morphologically, according to a representative view: "Generally the uniting nuclei *are almost perfectly alike*," though there may be slight differences in the size of the nucleoli. "The two cell-nuclei *do not differ in their nature*, they *are not sexually differentiated* in the ways that the individuals are from which they originate. All sex-differentiations *only serve to bring together* the two nuclei essential to the sexual process."

There are, however, different views, according to which the cell-substance also is of importance. However this may be, it becomes increasingly patent that every pronounced antithesis of size and shape is pernicious, whilst the observed uniformity of the two cell-nuclei again points to the eternal need of *normal* proportions.

§ 5. *Parasitism the real Starving of a Species*

Physiologically, as regards sexual unions, our biologists are entirely at sea. "Here experiment is almost insuperably difficult; only a few incidental results are as yet available." There are only suggestions, and "to some they may still appear a page of probabilities." Reference was already made to Rolph's view that conjugation occurs when nutrition is diminished. It is, however, perfectly ludicrous to speak as he does of a normal "gnawing hunger" in the case of parasitism.

Fertilisation in hunger or *in articulo mortis* may be the last expedient towards maintenance of a species; nay, its occurrence during real hunger may not infrequently be preferable to fertilisation under so-called "favourable conditions," *i.e.* a state of surfeit; but, however this may be, we must have a clear analysis of every case before rushing to conclusions.

We may, however, well concede that in a deeper sense parasitism in spite of the external presence of a surfeit of food, really means a starving of the species; that as it progresses, the retributive call for reproduction being increasingly felt, produces a perpetual exhaustion which is a kind of hunger.

§ 6. *Weismann denies Dynamical Action in Fertilisation*

Weismann "denies that there is a dynamical action in fertilisation." "The germ-plasma in the male and female reproductive cells is identical." To him "the process is quantitative rather than qualitative."

This view, prompted probably by his germ-plasm theory, but not according with his general contentions regarding the intermingling of the two hereditary tendencies productive of individual characteristics, is in opposition to a number of factors pointing to the contrary, as Geddes and Thomson rightly show. Thus for instance: "The occasional possibility of inducing division by replacing the sperms with other stimuli, seems to point to a dynamical or chemical action"; and again (though going too far): "A due impression of the marvellous 'individuality' of the nuclear elements may be combined with a general physiological interpretation of the entire process."

§ 7. "*Nutritive Wants*" *an entire Assumption*

In view of all this uncertainty and misapprehension, there seems therefore no warranty for the conclusions of Geddes and Thomson that :—

"Historically, then, fertilisation is comparable to mutual digestion, and, though bound up with reproduction, has arisen from a nutritive want. With the differentiation of the elements on anabolic and katabolic lines, the nature of the fertilising act becomes more definite. The essentially katabolic male cell, getting rid of all accessory nutritive material contained in the sperm-cup and the like, brings to the ovum a supply of characteristic waste-products or katastates, which stimulate the latter to division. The profound chemical differences, surmised by some, are intelligible as the outcome of the predominant anabolism and katabolism in the two elements. The union of the two sets of products restores the normal balance and rhythm of cellular life. Rolph's suggestion is thus included and defined."

The "nutritive want" is an entire assumption, the connections between nutrition and sex being inadequately delineated. Excessive nutritional craving is equivalent to exaggerated forms of metabolism; and it is putting the cart before the horse to say that the incidental metabolism produces the differentiations —except in so far as its abnormal modes may aggravate the developments. Weismann, we are told, derides this whole idea of exhaustion before union, though on other grounds than those here advocated.

The question, "Why should fertilisation occur at all, if parthenogenesis in some cases works so well?" appears to Geddes and Thomson as partly almost "illegitimate." They are satisfied to think that the existence of the male and female is "simply the expression of a more developed swing of the organic see-saw, between anabolism and katabolism," and that "the origin and physiological import of fertilisation can never be explained by any elucidation of its subsequent advantageousness." But what if a subsequent advantageousness of a more universal nature than mere Darwinian "usefulness" can be demonstrated as a sequel to a previous conformity to law and as founded on a teleological rationale? The apparent "advantage" of parthenogenesis will then be seen in a different light.

Nevertheless, "to Weismann, fertilisation is the ever-recurrent beginning of new vital changes, and the continual preservation at the same time of the *relative constancy* of the species," whilst Galton has insisted, "with much clearness and force, on the liability of asexual, or what he calls unicellular, multiplication to end in degeneration or extinction, and on the necessity of double parentage for the preservation and progress of the species."

SUMMARY

The "losing game" of cell-life is based on dysteleological causes.

The metaphor of "hungry and starving" male cells imputes a pathological significance (not normally chargeable) to the process of fertilisation. Is it true, however, that reproduction is frequently pathologically determined.

The ultimate and constant constitution of each of the two uniting cell-nuclei is the same.

" Isophagy " in parasitism is entirely pathological, although parasitism—surfeit notwithstanding—in a very real sense means a starving of the species. The idea of " hunger " and " exhaustion " before sexual union is an assumption, and can only metaphorically refer to abnormality.

CHAPTER V

PARTHENOGENESIS

"Ce que la chimie et la mécanique croyaient le mieux connaître était en réalité ce qu'elles connaient le moins."—LE BON.

"C'est un fait remarquable que les Champignons qui sont répandus dans la nature avec une si extraordinaire abondance, n'aient pas pu évoluer. Ils ne s'élèvent pas organiquement au-dessus des tissus qui, chez les végétaux supérieurs, se forment dans le sac embryonnaire de l'ovule et précèdent le développement germinatif du nouvel individu. Ce sont, pourrait-on dire, les avortons du monde végétal. Leurs diverses espèces constituent autant d'impasses, comme si en renonçant au mode d'alimentation ordinaire des végétaux, ils s'arrêtaient sur la grande route de l'évolution végétale."—HENRI BERGSON.

§ 1. Multiplication rather than Individuation.
§ 2. Female Preponderance.
§ 3. Male Parthenogenesis not Unknown.
§ 4. Conclusions of the *Evolution of Sex*.
§ 5. Dissociative Factors.
§ 6. Where does Pathological Parthenogenesis set in?
§ 7. Occasional Parthenogenesis.
§ 8. Conditions of Seasonal Parthenogenesis.
§ 9. Colloid Metals and Partial Dissociation.
§ 10. Juvenile Parthenogenesis.
§ 11. Total Parthenogenesis and its Associations.
§ 12. Insectivorous Generations.
§ 13. Parthenogenesis among Plants.
§ 14. Loss of Progressive Differentiation.
§ 15. Parthenogenetic Offspring.
§ 16. Effects of Parthenogenesis.
§ 17. Fertilisation and Progress.
§ 18. Precocious Peculiarities.
§ 19. "Favourable Conditions" tend to Parthenogenesis.
§ 20. Why are Internal Parasites not Parthenogenetic?

§ 1. *Multiplication rather than Individuation*

Parthenogenesis or "degenerate sexual reproduction" constitutes a case of decrease of teleological status due to metabolic degeneracy with consequent dissociation. It implies a parasitic replenishment of energy from "hosts" or catalytic agents, and is a phenomenon occurring in varying degrees of malignancy. It means quantity rather than quality.

If we turn for an inorganic analogy of similar dissociation to Gustave Le Bon (*L'évolution de la matière*), it appears in the following words :—

"Il semble extrêmement probable qu'un grand nombre des réactions inexplicables dont nous avons parlé, au lieu d'atteindre seulement les édifices moléculaires, atteignent, également, les édifices atomiques et mettent en jeu les forces considérables dont nous avons prouvé l'existence dans leur sein." ("It seems very probable that a considerable number of inexplicable reactions previously referred to, not only affect the molecular structure, but likewise the atomic structure, thus unlocking the mighty forces [intra-atomic energy] which we have proved to exist within the atom.")

Parthenogenesis likewise, I contend, affects the very intra-cellular strongholds of a species.

The same writer shows us from the case of catalysis how slowly and unobserved the subtlest modes of liberation of energy may proceed, and how it occurs in some of the most important processes of the organic and inorganic worlds.

"Although catalytic actions were early known, it is only in the last few years that they have been proved to play a preponderant part in the chemistry of living beings. It is now admitted that the diastases and various ferments whose rôle is so important act only by their presence."

"On closely examining the rôle of bodies *acting by their mere presence*, we note that they behave as if energy were transported from the catalysing body to that catalysed. This fact can hardly be explained, in my idea, unless by the catalysing body undergoing the commencement of atomic dissociation. We know that, by reason of the enormous velocity possessed by particles of matter during its dissociation, considerable quantities of energy can be produced by the dissociation of a quantity of matter so imponderable as to elude all attempts to weigh it.

"*The catalysing substances should therefore be simply liberators of energy.*

"If this be really the case, we ought to be able to note that the catalysing body at length undergoes a certain alteration. Now, this is exactly what is verified by observation. Platinum black and the colloid metals are in the long run worn out—that is to say, by use they lose a great part of their catalysing action."

We shall presently see that similar dissociative factors play a prominent part in the various phenomena connected with parthenogenesis.

§ 2. *Female Preponderance*

Parthenogenesis was defined by Von Siebold as "the power possessed by certain female animals of producing offspring without sexual union with a male."

This "power," however, implies a retrograde adjustment, and is purchased at too high an expense to possess a lasting value. The female preponderance, in my view, is but an indication of antithetic development.

The sex distinction itself is almost undue in such cases, where we have a wholesale reversion of sexual organisation to a more primitive level.

In other words, the differentiation accompanying the usual arrangement of male and female is wiped out to make room for more primitive combinations. It is in consequence of the pathological puzzles constantly associated with it that the whole case strikes us as prodigious and enigmatical.

§ 3. *Male Parthenogenesis not Unknown*

It has indeed turned out that "male parthenogenesis, paradoxical as it sounds, is really exhibited among lowly algæ. That is to say, a small spore (or male cell) which normally unites with a larger and more quiescent one (or female cell) may occasionally start developing on its own resources."

Although the result is said to be "poor enough," it is yet evident that the case bears out my contentions as regards a general reversion in all such cases. Nor can we be astonished to find parthenogenesis persisting in some cases for a length of time with apparently all the symptoms of "a confirmed physiological habit." Dissociation proceeds very gradually, and as long as an indolent and easy replenishment of energy from a "host" or "catalytic agent" is possible, the real exhaustion may for a considerable time not become apparent. I have previously alluded to concrete examples where mere forms may persist for a long time from sheer impotence of variability.

§ 4. *Conclusions of the "Evolution of Sex"*

The following are the conclusions on parthenogenesis arrived at in the *Evolution of Sex*:—

1. Parthenogenesis was formerly believed to be of wider occurrence than it really is, but it is definitely known to be not uncommon in lower animals.
2. Artificial, pathological, occasional, partial, seasonal, juvenile, and total parthenogenesis must for clearness be distinguished.
3. The occurrence of parthenogenesis is especially well seen in rotifers, crustaceans, and insects.
4. It is rare among plants, but certainly occurs in some of the lower forms.
5. The offspring of parthenogenetic ova is very diverse.
6. The effects of parthenogenesis on the species deserve consideration, especially by those who find in sexual intermingling the sole fountain of specific variation.

7. Parthenogenetic ova, so far as observed, form only one polar body.

8. Parthenogenetic ova are here regarded as imperfectly differentiated female cells, retaining certain male or katabolic characteristics.

9. In origin parthenogenesis is regarded as a degeneration from the ordinary process.

§ 5. *Dissociative Factors*

Let us now proceed to deal with the various forms as they are here presented.

Artificial Parthenogenesis. — "There are a few curious observations which go to show that in exceptional circumstances ova may develop when the male stimulus is replaced by some artificial reagent. These observations must still be taken *cum grano salis*, but they may be at least suggestive of further experiment. Dewitz observed unfertilised frog ova to undergo segmentation [*sic*] in corrosive sublimate solution. In some cases one division occurred, in others several; in some cases irregularly, in others normally. It happened both when the ova were left in the reagent and when they were *merely dipped* and returned to water. The eggs experimented on were those of the two common frogs, *Rana fusca* and *R. esculenta*, and of the tree-frog (*Hyla arborea*). But it must be noted that Leuckart long ago noted the occurrence of spontaneous division in frog ova. Similarly, Tichomiroff, experimenting with the unfertilised ova of the silk-moth, which are occasionally parthenogenetic, was surprised to observe that ova, which would not of themselves develop parthenogenetically, might be induced to do so by certain stimuli. These consisted *in rubbing the unfertilised ova with a brush*, or in dipping them for two minutes in sulphuric acid and then washing them. In both cases, he says, a percentage of the ova thus artificially stimulated developed. It must be remembered that *occasional parthenogenesis occurs in this insect*, and all that Tichomiroff did was to incite this. There is no doubt that reagents may considerably modify ova; thus the brothers Hertwig showed how it was in this way possible to overcome the non-receptivity of the ovum to more than one sperm. Nor can one forget how sexual reproduction in parasitic fungi tends to disappear, *being apparently replaced by the stimulus afforded from the waste-products of the host*. In a similar way, the multiplication of cells, so frequently associated in disease with the presence of bacteria, has been referred by more than one pathologist to the 'spermatic influence' of these micro-organisms, or of the katastates which they form."

Again we can see the great need, referred to before, of discriminating in our analysis as to the components present in an organic system. Thus, in the case of the silk-moth, the previous knowledge of the occasional parthenogenetic behaviour of the ova is an essential factor in Tichomiroff's inciting experiments. We may draw the vital inference that various strains are always more or less perceptibly present, and that all we occasion with our experiments, is to cause the one or the other to predominate.

Just as Mendelism has shown individuals externally alike yet not necessarily possessing the same breeding qualities, or again as Le Bon's indictment of former methods of chemistry has brought to light the need of greater discrimination in methods and in analysis, so we have yet to learn to use greater discrimination in estimating the presence and force of the various biological factors concerned in every system.

What, then, is the full meaning of the disappearance of sexual reproduction in parasitic fungi under "the stimulus afforded from the waste-products of the host"? Only along the lines of organic dissociation can an adequate and cogent explanation be found.

The reference made in this connection to "spermatic influences" of micro-organisms is of the greatest importance especially in the light of the new biological outlook as I have so far attempted to delineate it.

§ 6. *Where does Pathological Parthenogenesis set in?*

The discrepancy of an altogether too partial treatment of pathological factors again crops up very strikingly in the observations on "Pathological Parthenogenesis," under which heading only a few very abnormal occurrences among higher animals are deemed worthy to be classed.

Again, in the *Evolution of Sex* we have the following statement :—

"It has very occasionally been noticed in higher animals, where true parthenogenesis is wholly unknown, that an unfertilised egg starts off on its own resources without any male stimulus whatever. This is noted by Leuckart for frog ova, by Oellacher for hens' eggs, and by Bischoff and Hensen even in mammals. Such cases must be regarded as rare abnormalities, comparable perhaps to pathological formations which not unfrequently take place in the ovary, and it is hardly necessary to say that in no case did the development proceed far. Balfour has also cited a remarkable observation of Greeff, who saw unfertilised ova of the common starfish developing in ordinary sea-water, in a perfectly normal fashion, only more slowly than usual."

Gustave Le Bon, however, in the analogy of chemical species, supplies a cogent explanation of the *modus operandi* of such artificial parthenogenesis. To him, the various means of inducing electricity, for instance by means of friction (*frottement*), in reality serve the purpose of dissociating matter ; the setting free of its finest particles thus giving rise to the manifestation of electricity. "Electrification by friction," he says, "on which the old statical machines were founded, constitutes a means of breaking up the atom, setting free its 'intra-atomic' energy." "Friction only multiplies and renews the heterogeneous surfaces present."

As I have throughout compared this "intra-atomic" energy to "intra-cellular" energy, *pari ratione*, I maintain that in parthenogenesis the generic equilibrium is upset, the species living in spendthrift fashion on its capital.

We must remember that, according to Le Bon, in the case of chemical species "spontaneous and violent radio-activity (dissociation or liberation of 'intra-atomic' energy) will only appear when the bodies in question have previously been 'engaged' in certain peculiar chemical combinations capable of affecting the stability of their atoms. These experiments even led me to modify entirely the properties of certain simple bodies," says Le Bon, "by the addition of minute quantities of foreign bodies."

The success of "rubbing" operations depends precisely on the degree of instability presented by the species.

"Prenons un sel quelconque, du chlorure de potassium par exemple, nous pouvons indéfiniment le broyer, le pulvériser avec les machines les plus puissantes, sans jamais réussir à séparer les molécules dont il se compose."

The striking analogy of organic and inorganic cases of dissociation thus reminds us again of the origin of disease in instability (susceptibility). It is a fatally arbitrary proceeding to classify only the extremes of disease as pathological, and to rank incipient and intermediate stages as normal.

§ 7. *Occasional Parthenogenesis*

" In some of the lower animals, which are not themselves normally parthenogenetic, but have relatives so addicted, occasional parthenogenesis has been frequently observed. These differ from the above cases, since the results are more successful, often in fact reaching maturity, and also in this, that since related forms are parthenogenetic, the 'abnormality' is evidently of a much milder type. The common silk-moth is a good example of this occasional parthenogenesis, which certainly occurs, though rare both in the genus and family. 'A whole series in insects,' Weismann says, 'reproduces exceptionally by parthenogenesis, for instance many butterflies, but that never to the extent that all the eggs which an unfertilised female lays develop, but only a fraction, and usually a very small fraction, of the total number, the rest perishing. Examples of successful occasional parthenogenesis (to the extent at least of producing males) are furnished by those worker bees, wasps, and ants which exceptionally become fertile.' "

The case of the silk-moth, which presents a striking instance of physiological "misère," must be reserved for more detailed study in a subsequent volume. The perishable nature of parthenogenetic ova, alluded to by Weismann in this connection, is highly symptomatic of the deficiency of vitality.

Regarding "partial parthenogenesis," in the case of the queen bee, where the unfertilised eggs are supposed to develop solely into drones, "we cannot, however, say that the absence or presence of fertilisation is the sole difference, though if fertilisation be prevented by the imperfect development of the wings, or by clipping them, the queen only lays drone eggs. The same happens when she is old and her store of male elements exhausted, or when the sperm receptacle has been removed."

Though, by an interference with the vehicles, we may produce changes of polarity, this in no way invalidates the idea that in reality it is potential that counts in fertilisation. It is evident, moreover, that every impediment to natural developments is equivalent to a lowering of potential. So long as this factor is disregarded in biological experiments, there is grave danger of the *post hoc ergo propter hoc* pitfall.

Occasional parthenogenesis, however, is no doubt the analogue of occasional dissociation.

Organic polarity is possessed of powers of inertia comparable to those of an equilibrium, since they resist dissociation. With diminishing resistance, however, strange currents and inductions are set up. Reproduction proceeds pathologically and, finally, parthenogenetically.

"The change of velocity of an electrolysed body," says Le Bon, "in virtue of the inertia of the electrical particles, results in the production of phenomena called induction, that is, the creation of a new electric force manifesting in a direction perpendicular to that of the magnetic lines, and consequently in the direction of the current. A variation in the magnetic field thus causes the production of an electric field."

§ 8. *Conditions of Seasonal Parthenogenesis*

"In some of the minute aquatic crustaceans (Cladocera), popularly included under the general title of water-fleas, parthenogenesis only occurs for a season, and is periodically interrupted by the birth of males, and the recurrence of the ordinary sexual reproduction. Males generally reappear in the disadvantageous condition of autumn, but Weismann denies that there is a direct connection between these facts. The common Aphides are parthenogenetic for a succession of generations, sometimes as many as fourteen, throughout the summer, but the cold and hard times of autumn bring back the males and the sexual process. The fertilised egg lives on through the winter, and develops with the warmth of the next spring. By keeping up the temperature *and nutritive optimum* for three or four years in the artificial summer of a glass case, Réaumur and Kyber succeeded in rearing as many as fifty continuous parthenogenetic generations. In the gall-wasps (Cynipidæ) there is usually one parthenogenetic generation between the normal sexual reproductions, but in many insects besides Aphides there are several. It ought to be noted that the parthenogenetic Aphides are hardly at the same structural level as the females which are fertilised; but as the differences mainly lie in the absence of certain accessory genital organs, there is no reason for regarding the parthenogenetic forms, as some have done, as larval."

According to my view, the difference between sexually and parthenogenetically produced Aphides consists primarily in potential, and it is to be expected that such changes should conspicuously affect the structural level. With these simple organisms the predominant nutritive stimulation easily produces an overflow in the parthenogenetic direction, from which the species may be rescued by a return to normal conditions of life allowing the sexual alternation.

It is possible that through such periodically recurring alternations, through satiety followed by retribution and disgust, species may gradually evolve a certain evolutionary strength, which would lead eventually to a greater stability of protoplasmic and generic conditions.

We have seen, in the same way, how a primordial hermaphroditism had its uses in evolving and fixing a phase of bilateral symmetry. Organic polarity and powers of ancestral dynamics in general are thus based on formidable factors of past evolution. Réaumur's and Kyber's experiments, however, only remind us of those crude approximations obtained in chemistry where no notice is taken of the fact of the dissociation of matter. They only indicate that, if we continue acting upon a compound in the same way and under the same conditions, approximately the like phenomena of dissociation may be obtained for quite a long time.

§ 9. *Colloid Metals and Partial Dissociation*

Interesting cases of partial dissociation of metals, illustrating the prodigious nature of disaggregating phenomena in general, are related by Le Bon in the case of the colloid metals.

"One of the best types of substances which elude the ordinary laws of chemistry is represented by the colloid metals. One of the methods of preparing them should alone suffice to indicate, apart from their very special properties, that their atoms must be partly dissociated. We have seen that, from the metallic poles of a static machine in motion, there issue, as the result of the dissociation of matter, electrons and ions. Instead of a static machine let us take, for the convenience of the experiment, an induction coil, the poles of which terminate in rods of the metal we wish to dissociate—gold or platinum, for instance—which are plunged in distilled water. By making sparks pass between the two rods, as described by Bredig, a cloud will be seen to form round the electrodes. After a certain time, the liquid becomes coloured and contains, in addition to the metallic particles torn from the electrodes and separable by filtration, something unknown and proceeding from the dissociation of the metal. It is to this unknown thing that the name of colloid metal has been given. If the operation be long continued the colloid ceases to form, as if the liquid were saturated."

It is not difficult to see that the case of the colloid metals presents a close analogy to various phases of organic disaggregation.

§ 10. *Juvenile Parthenogenesis*

From mere "seasonal" parthenogenesis to that state of degeneracy which necessitates juvenile parthenogenesis is a big leap; the pathological difference is so vast that it constitutes a great incongruity to set the one phenomenon next to the other. Whilst in seasonal parthenogenesis—although an extreme—we have an almost orderly alternation, an exaggerated swing of the organic see-saw, in juvenile parthenogenesis we meet with a ghastly distortion of heredity, with a terrible reproductive nemesis.

"Cases do occur, however, where larval forms become precociously reproductive (as sometimes happens among higher organisms), and produce offspring parthenogenetically. Such precocious production of parthenogenetic ova must be distinguished from the entirely asexual reproduction exhibited by many larvæ. No very firm line can indeed be drawn, but in the last cases no cells which can be called ova are present. In 1865 Professor N. Wagner observed what has been much studied since, that in the larvæ of some two-winged or dipterous midges (*e.g. Miastor*) the cells of the reproductive rudiment develop into larvæ within the mother-larva's body. The mother falls victim to her precocity, for the brood of seven or ten *larvæ literally feed upon her to the death.* They finally leave the corpse and begin life for themselves, only, however, to fall themselves victims to a similar fate. The process may thus go on for several generations, during which the ova, or pseudova, as some would insist upon calling them, become smaller and smaller. Eventually the larvæ become too constitutionally poor to be precociously parthenogenetic, and develop into adult midges—male and female, the latter producing, however, only a few eggs.

"In another dipterous insect known as *Chironomus*, the ova begin to be produced at a very early stage, are laid just at the time when the larval life ends, and develop parthenogenetically. According to Jaworowski, by the rupture of the ovarian membrane the ova fall into the body-cavity, where the *abundant nutritive stimulus takes the place of fertilisation.* Juvenile parthenogenesis is also said by Von Siebold to occur among the Strepsiptera, little insects which infest bees."

I have already traced the connections between such pædogenetic developments and parasitism, and there can be no doubt that here again we are dealing with retributions and curtailments of the predatory life.

In the case of the *Aphides*, the nemesis of a summer's revels consists in a seasonal exhaustion and the chastisement of a reaction presented by a famishing condition, and similarly the transgressions of *Miastor* and *Chironomus* are visited by the most severe modes of reproductive nemesis. The precocious production is conditioned by requisites of reproduction, and the visitation is commensurate with the parasitic mode of life.

It must be remembered that these insects are highly parasitic, preying upon every description of animal and vegetable matter, always preferring such as is in a state of putrefaction. Their metabolic state is associated with pathology rather than with teleological beneficence, that is to say, these organisms diverged from the true evolutionary path, and have therefore become involved in a series of clashes and disharmonies which are tantamount to disease.

It can hardly be termed a "natural" selection when we behold ten larvæ literally feeding upon the mother to the death. It is, however, readily understandable as a case of "retributive" curtailment of the degenerate's life.

§ 11. *Total Parthenogenesis and its Associations*

"Lastly, in some of the minute aquatic crustaceans and in many rotifers no males have ever been found. There is every probability that the parthenogenesis is thus total; and as the numbers are abundant, it has apparently been established without detriment to, at least, the continuance of the species."

I have already inferred that these conjectures as regards the continuance of the species must be taken with a large grain of salt. We have seen how most vital phenomena of dissociation have for long escaped observation, how their manifestations may be very gradual, with innumerable possibilities of inconspicuous intra-cellular rearrangements, until finally all differentiation is lost. Those low grades approaching nearest in their habit of life to the passive plant, like many aquatic crustaceans, for instance, drawing only infinitesimally on their own forces and relying on external stimuli—may long persist under a degenerate and very slowly decaying arrangement of sex, which easily deceives us as regards the true physiological robustness of the species. In a similar manner, plants which have been induced to change in a dissociative direction show a reduction of survival capacity.

"La destruction de la matière," says Gustave Le Bon, "se fait d'une façon si lente qu'elle n'est pas perceptible par les moyens d'observations anciennement employés."[1] The case of "total parthenogenesis" may thus resolve itself into one of imperceptible dissociation. The peculiarities of the aquatic habitat lend themselves particularly to prolonged equilibrations, as the fossil remains of many persistent types of fishes testify.

"In these distinct sets of animals—rotifers, crustaceans, and insects—parthenogenesis has become a confirmed physiological habit" (*Evolution of Sex*).

Let us see.

"(*a*) Take first the curious little rotifers, or wheel-animalcules, which abound both in fresh and salt water. They are usually *placed in the chaotic alliance of worm-types*, and have long been famous for their alleged power of surviving prolonged desiccation. With one or two exceptions the males are *markedly different from the females*, and are *usually small and degenerate.* In one group (Philodinadæ) the females have two ovaries, while males have never been found. They have dwindled out of existence. In the rest the females have one ovary, part of which has degenerated into a yolk-gland, and small males occur. These are quite superfluous as mates, however, for parthenogenesis prevails. Even when impregnation, which is a peculiarly random process, occurs, the sperms appear to miss their mark, and to perish in the body-cavity. The *numbers keep up*, *notwithstanding*, so that we have here an entire class where parthenogenesis has firmly established itself.

---

[1] ("The disaggregation of matter proceeds so slowly that it is not perceptible by the means of observation heretofore employed.")

"(*b*) Among crustaceans, parthenogenesis is restricted to *the lower orders*, viz. branchiopods and ostracods. In the former, it is exhibited by the brine-shrimp *Artemia* and the common fresh-water *Apus* in one division; by daphnids (*e.g. Daphnia* and *Moina*, common "water-fleas") in the other. In ostracods, some species of the common *Cypris* are parthenogenetic. If a female water-flea, say *Daphnia*, be isolated from birth, she becomes the mother of an abundant progeny of females. Males and sexual reproduction do, however, eventually return, and *the same is probably true of the majority.* Among three thousand specimens of the brine-shrimp only one male occurred; while Von Siebold repeatedly investigated every member of a colony of *Apus*, once over five thousand in number, without finding a single male.

At other times he found one per cent., while in certain unknown conditions (probably when food is scarce and life generally unfavourable) the males may be developed in crowds."

The parasitic habit, the impure associations, the antithetic development, the "dwindling out of existence" of the males, the occurrence of yolk-glands, all tell their own tale.

In view of all this, it is poor consolation that numbers keep up notwithstanding.

It is significant that the brine-shrimp distinguishes itself again in this connection. The sexual antithesis that it, like the *Apus*, represents, can have but one significance. Their improper ratios of 1000 : 1 and 5000 : 1, which their cases respectively represent, are in direct proportion to their dysteleological life and explain the waning inner strength.

The reappearance of the male in crowds in certain unknown conditions ("probably when food is scarce and life generally unfavourable") seems rather incompatible with the theory of the "isophagy" on the part of the tiny, starving and exhausted male seeking the fine fat female to still his gnawing hunger. He would at least seem a most unseasonable visitor, on this theory. Had he not better time his visits to periods of plenty, when the female may reasonably be supposed to be fatter, and more generously disposed to boot? Even if it is retorted that a mere unproductive tiny scamp of a male has no choice in the matter, but that the *force majeure* of economical conditions must determine the event, it must be considered an economic blunder to "produce" katabolic males in the face of scarcity of food.

If such "production," however, is due to a reduction of degeneration, *i.e.* to a teleological influence, then we can see that it may indeed imply a rejuvenation of the species.

§ 12. *Insectivorous Generations*

We come next to the case of insects. In some butterflies "the males seem to disappear for a stretch of years, and the species gets on without them. The male of *Psyche helix* is very rare, and *was for long unknown.* When the males are developed in *Solenobia trinquetrella,* it is interesting to notice that they may predominate in numbers over the females. *A whole brood may* be male; they are brought back with a rush."

Can we not see in these phenomena that inherent tendencies towards equipoise, inherent—and, indeed, essential—reminiscences and strains of the opposite sex, however apt to be overlooked, must yet be present in all these alleged cases of total parthenogenesis? It only needs a return to more appropriate conditions, for a reaction towards the normal proclivities to set in. "Forms which had been regarded as quite distinct, and have received different generic titles, have been shown in about a score of cases to be merely the parthenogenetic and normal forms of the same insects."

The case reminds us of allotropic modifications, of the various forms of dissociated matter, and of the diffusion of strains described in Mendelism, all showing that names in the last analysis are but a convenience.

It illustrates again how degeneration may "polymorphise" normal developments. We may reasonably suppose that the oddities which occur have only very partially been discovered, and that, moreover, many instances of supposed heterogenesis mean nothing more than the resuscitation to a former higher level of organisms lapsed into primitive states through illegitimacy of life.

§ 13. *Parthenogenesis among Plants*

As regards plants, we read (*Evolution of Sex*) that their passive bias is so strong "that it is easy to understand the rarity of parthenogenesis. The egg-cell which develops of itself *must retain the stimulus* which the male element in other cases supplies. It is natural, then, that what predominates in the active rotifers should be uncommon in the sleeping plants."

A metabolic distinction—as between animal and plant—is thus at last conceded, although it had not before received mention, let alone due consideration.

Plants, however, have their own dysteleological modes; and if in their case the nutritive diathesis produces other modifications, this is explicable by the different mode of life and of teleological status. The power of retention alluded to is proportionate to general biological vigour, and we must assume the animal to be superior in this respect to the plant. With more freedom and more plasticity, the animal may well at times present more conspicuous forms of abuse.

To resume, however. "In the lower plants, there is no doubt on the subject. Parthenogenesis frequently occurs as one of the stages in the degeneration of sexual reproduction. It has been casually observed of a species of the stonewort (*Chara*) that when grown in certain waters the male organs disappear, yet the plants continue multiplying. More interesting are the Fungi. To illustrate sexual degeneration, De Bary gives a series from Fungi like those which kill the salmon and potato (Saprolegniæ and Peronosporeæ). What happens first, is the degeneration of the male organs. The katabolic sex from beginning to end is the more unstable. The male function goes first, but the form remains after the reality has ceased. After a while, that is, in related species, the form goes too."

Reference has already been made to the case of *Elodea canadensis*, and we saw there that under a straining of the powers of variability a destructive mode of degenerate reproduction was contrived. In the present case of the Fungi we can perceive how it is only a matter of time for the form to disappear in the wake of functions lost through very pronounced parasitism.

By parity of reasoning we would infer that the alleged stability of the female after the gradual degradation of the male can only be a chimera. The female is merely less unstable.

§ 14. *Loss of Progressive Differentiation*

The male may be said to represent the culmination of progress—not so much because of his maleness, but because of his duties under division of labour once a sufficiently high stage of development, justifying division of the sexes, is reached. As long as such prerequisites are fulfilled, the species may express itself in male and female; if they are deviated from, it has to surrender differentiation, and can express sex through one form only. The disappearance of the male thus marks the loss of biological potential. It is always the late acquired parts that are first lost in retrogression.

It is significant that we are now, after a brief summary of the series of steps of masculine decline, told that "parthenogenesis is thus reached, as the result plainly of a degenerative process. We can follow the story further, however. The male organ has degenerated, we have seen, while the female organ holds on its course. But this is not always so; in many cases *it follows suit*, and asexual reproduction remains."

It is evident that we are dealing with a universal retrogression, far transcending a mere casual or economical obliteration of the male. The confirmation is again near at hand:—

"Now why should these Fungi among plants exhibit numerous instances of parthenogenesis? *The more intimate the parasitism*, the more degenerate the sexual reproduction, and all trace of it is often lost. *The Fungus fertilises itself* from its host. In the Fungus on the coffee-plant, for example, the stimulus of fertilisation is replaced, as it were, by an 'essence of coffee.'"

The "essence of coffee" is merely one of the appropriate excitants required to hasten the intracellular dissociation of the Fungus in the course of his parasitic excursions. The more it indulges, the more must it lose of its teleological status, the less can it afford to express itself as male and female (female and male, we should now say).

§ 15. *Parthenogenetic Offspring*

With regard to "the offspring of parthenogenesis," the following interesting factors are set down:—

"The fates of parthenogenetic ova are very diverse. They may all perish, or all succeed; they may turn out wholly males or wholly females. Hensen notes the following suggestive series, with decreasing reproductive, as opposed to constitutional, energy at each evel:—

(1) Hermaphrodites, then only females.
(2) Series of females, then mixed brood.
(3) Several females, mixed brood, then only males.
(4) Series of mixed broods, then males, or death of ova.

(5) Mixed brood, with much mortality.
(6) Males only.
(7) Development only for a few stages.

Rolph has a different arrangement, but the same idea :—

(1) Exceptional parthenogenesis with uncertain result (*e.g.* Silk-moth).
(2) Normal, producing males only (females solely from fertilised ova) (*e.g.* Bees).
(3) Mostly males, with occasional females (*e.g.* *Nematus*).
(4) Mostly females, with exceptional or periodic males (*e.g.* *Apus*, *Artemia*).
(5) Only females, males unknown (*e.g.* many Rotifers).

"That parthenogenetic ova should develop with such diverse results is not at all surprising. The absence of fertilisation removes one of the factors determining sex; but food, temperature, age of ovum, etc., remain, and produce bias now to one side, now to the other."

The various fates of parthenogenetic ova are determined by retributive adjustment.

It is not the absence of fertilisation, but the presence of parasitism, that removes the "sex-determining" factors, by setting up antithetic developments and calling for extrusions. Mendelian ratios no doubt are thus frequently borne out in these various fates of parthenogenetic ova, and would have to be separately considered. The greater the degree of parasitism, the more (in Mendelian parlance) will the "rusty" conditions appear as "dominants."

The mere masking of the male strain—the loss of its traces, as Geddes and Thomson carefully express it—also becomes more readily understandable on the lines of Mendelism.

It will be difficult to demonstrate the *modus operandi* of these inner occurrences in a more satisfactory way than by comparing them throughout with the changes in a dynamic system, which is precisely what I have repeatedly advocated.

§ 16. *Effects of Parthenogenesis*

The effects of parthenogenesis are what, on the theory so far propounded in this volume, we may well expect them to be. Those who are in the position of "authorities" on points of heredity, however, seem to be far from unanimous in the matter, as appears from the following :—

"Since parthenogenesis is dominant in rotifers, and well established among water-fleas and plant-lice, it is very plain that, whatever else it effects, it is *anything but prejudicial to numbers.* An aphis will continue for days producing a viviparous brood, at the rate of one per hour ; the offspring soon begin themselves to multiply ; and Huxley calculates, that if this continued for a year without mortality, a single aphis would be the ancestor of a progeny which would weigh down five hundred millions of stout men! Not gardeners only have cause for gratitude that climate and enemies prevent such untoward increase. *But there are other* *desiderata* besides numbers. Can it be said that parthenogenesis favours the general life and progress of the species? It will be at once recognised that rotifers, brine-shrimps, water-fleas, aphides, coccus-insects, and so on, are *relatively low forms.* Only two or three butterflies and one beetle are parthenogenetic. Higher up in the scale, virgin birth never occurs except in a very partial and pathological degree. But we can go further. More than one of the old naturalists, and in recent years Brooks, Galton, Weismann, and others, have laid emphasis on the value of fertilisation as a fountain of change. To Weismann the intermingling of the male and female 'germ-plasmas' in fertilisation is really the sole source of variation. That it is *a* source, all will admit. If it be removed, therefore, as in rotifers, the species will be so much the less likely to progress. Weismann holds that it will not progress at all; and though we should not go quite so far, we are bound *to allow that the establishment of parthenogenesis is a handicapping of evolution.*"

Huxley's figures bear an unmistakable analogy to those recently obtained by physical science concerning the prodigious character of intra-atomic energy and of its dissociations. I have already demonstrated that in view of the existence of teleological checks all such calculations of what might theoretically be possible by such modes of "fecundity" are of little practical use. They indicate, however, that tremendous forces and potentialities are locked up in teleological integration.

Whilst they could not help being forced to the recognition that "the establishment of parthenogenesis is a handicapping of evolution," it seems almost a strange prejudice on the part of Geddes and Thomson not to admit the same of parasitism, which they find themselves repeatedly driven to recognise as an intimate "associate" of the most degenerate forms of sexual reproduction.

But the conclusion must now appeal to the unbiassed mind, that parasitism is the prime cause of dysteleological developments. If in parthenogenesis this fact is expressed in a peculiarly startling and sometimes ghastly manner, it is certain that this factor must also have produced the less conspicuous effects in the same direction.

§ 17. *Fertilisation and Progress*

If the effects are reasonably interpreted, the whole case of degeneration, from its incipient stages to its final catastrophe, becomes intelligible.

To say that fertilisation is of great value as a "fountain of change," and that "if it be removed, as in rotifers, the species will be so much the less likely to progress," is, in my opinion, to make an inadequate statement. It is putting the cart before the horse. It is really because of the unprogressive and parasitic mode of life—from a previous cause—that sexual fertilisation is lost. "Removal" of fertilisation is incidental on retrogression rather than *vice versa.*

Present-day confusion in biology, however, again comes out very markedly in the following divergent opinions summarised in the *Evolution of Sex*:—

"We cannot, however, follow Weismann in his next step. If all change springs from the sexual intermingling, the rotifer species cannot change at all. They cannot go forwards, nor yet backwards. Having attained to a physiological state when males become superfluous, they remain *in statu quo*. So he emphasises that superfluous organs, such as the sperm-receptacle, do not become rudimentary in parthenogenetic species,—'rudimentary organs can only occur in species with sexual reproduction.' This is a corollary of Weismann's contention that no individually acquired characters, either plus or minus, can be transmitted, and that the sexual intermingling is the sole source of change affecting the species. Were the main propositions proven, the corollary would follow; but there are still many dissentient voices. Without going into the general question at present, let us take the corollary by itself.

"(1) Cases where males are quite unknown are comparatively few; in most cases they reappear at intervals. It is not possible, therefore, as Weismann will allow, to be *certain* that the sperm-receptacle becomes superfluous to the species.

"(2) He also allows that it does degenerate in the summer aphides, where the periodic disappearance of males is well known.

"(3) In spite of the absence or else futility of impregnation in rotifers, we find the males obviously in process of degeneration.

"In conclusion, we believe, with Weismann and others, that the absence of fertilisation is a minus in evolution, but see no warrant for supposing that it absolutely precludes either progress or the reverse. The power of parthenogenetic birth has two different results: (1) The female cell has a certain maleness about it; it retains the stimulus which the male element usually affords; the species will therefore be frequently of active male-like habit, *e.g.* rotifers and water-fleas.

"(2) On the other hand, the long-continued production of females means an anabolic preponderance, means a weighting of the species; and this is seen in the sluggish plant-lice, coccus-insects, and the like."

There is no remaining *in statu quo* in this world of change; nor can there be on the hypothesis of evolution, nor on the supposition of dynamic interactions in life. Many changes, however, remain imperceptible to our limited vision. Nowhere, probably, is this shortsightedness and lack of comprehension more marked than in the sphere of biological change. Meantime, we must remember Le Bon's remarks on our failure to perceive unstable and transitional equilibria in the inorganic world. Again, it seems somewhat incongruous with the general argumentation on "virgin-birth" to declare that because of the female cell having a "certain" maleness about it, and retaining "the stimulus which the male element usually affords,"[1] the "species will therefore be frequently of active male-like habit, *e.g.* rotifers and water-fleas."

A "remnant" of male elements derived by a supposedly undegenerate and (in view of the obvious antithesis of size) highly "anabolic" female, from an exhausted and admittedly degenerate male, is declared sufficient to stamp an active male-like habit upon the species!

The sluggishness of the plant-lice, however, is set down to the anabolic preponderance in parthenogenesis. Thus, anabolism is now associated with activity and now with passivity, to fit the special case. Just as we have seen with regard to numbers, mere activity and passivity are delusive. The activity of the water-fleas may, for instance, be the outcome of their particular phase of dissociation.

§ 18. *Precocious Peculiarities*

Among the peculiarities of the parthenogenetic ova, that of reproductive nemesis takes first rank. "Simon shrewdly points out, that in some of the most marked cases of parthenogenesis the sex-cells are insulated from the body at a very early stage. This is notably so in those midges which reproduce parthenogenetically even before maturity. It is certainly striking that these forms should unite an extreme earliness in the embryonic separation of the germ-cells with a most precocious reproduction."

---

[1] I have, of course, no objection to the idea of the male-and-female character of the parthenogenetic series in itself.

I have already dwelt at length on the significance of such nemesis, and very appropriately from this point of view we are now told that, "on the other hand, some forms where parthenogenesis is unknown (*e.g.* leeches and *Sagitta*), also exhibit the same early differentiation of germ-cells, so that we can only look upon the fact as one of the auxiliaries of parthenogenesis."

But do these facts not rather point to the explanation that pædogenetic development forms the retribution of parasitism?

On page 180 (*Evolution of Sex*) we read the still more important admission, approaching my view of the universal character of the diathesis underlying these vicissitudes, that "*an ovum which retains a male element is not happily described as remaining asexual; it would be better to call it a case of intra-cellular hermaphroditism.*"

Is not all parthenogenesis a case of a more or less heterogeneous intra-cellular hermaphroditism? — inbreeding and reduction of status and environment resulting from infeeding?

All these lines of thought, properly pursued, must lead to the fundamental proposition that nature abhors perpetual self-fertilisation, and that its producer, parasitism, is the main force causing divergence from the true evolutionary path.

§ 19. "*Favourable Conditions*" *tend to Parthenogenesis*

Of other views on parthenogenesis, Strasburger's is worth noting: "In the rare cases of parthenogenesis, *specially favourable nutritive conditions* may counteract the lack of nuclear plasma." The favourable nutritive conditions here referred to are those of surfeit, which, I maintain, produces a pathological condition of the organism.

Rolph also having been forced to recognise the important connection of parthenogenesis with abundant nutrition, Messrs Geddes and Thomson observe that "it is important to notice how two naturalists so very different in their manner of attacking a subject as Rolph and Strasburger are, come to this conclusion at least in common, that '*favourable conditions*' favour parthenogenesis."

Weismann's statement that "parthenogenesis occurs when the entire sum of the ancestral elements persists in the nucleus of the ovum," points to an intra-cellular hermaphroditism.

§ 20. *Why are Internal Parasites not Parthenogenetic?*

Geddes and Thomson, in connection with their metabolic theory, see in parthenogenesis "no direct persistence of a primitive '*ideal*' state, though to some degree a recapitulation of it," but, not unnaturally, they ask themselves the question: "Why then are not internal parasites parthenogenetic?" According to the current notions, in their case, there is an "ideal" persistence of "favourable conditions," and a perfectly "ideal" primitive state should be the happy lot of those denizens of the human or animal interior. They are continuously bathed in nutritive fluids, and they are scarcely ever harassed by alternating hard or good times favouring "anabolic or katabolic conditions." Being so "ideally" circumstanced, there ought to be no need for them to resort to such low and deadly practices of multiplication as prevail among their exterior cousins who have to cope with such alternations. Their conditions of life should be paradisaically sweet and simple. Yet, protection, shelter, and "favouring conditions" notwithstanding, we find them mostly sunk below the status of their parthenogenetic relatives; and no wonder, for they have abrogated effort, evaded every modicum of teleological duty, and forfeited even the smallest measure of progressive differentiation.

"They are very generally hermaphrodites, and have moreover gone beyond parthenogenesis to prolific asexual multiplication."

The conclusion must again be, that parasitism is universally responsible for the decline of species in the organic scale.

SUMMARY

Parthenogenesis represents a case of organic dissociation under a parasitic replenishment of energy from "hosts" or "catalytic" agents. The female preponderance in parthenogenesis is but an expression of antithetic development and of degeneration from the higher state of sexual reproduction.

Parthenogenesis may be artificially induced by the identical methods which cause inorganic dissociation. The success of such artificial operations depends entirely on previous instability.

Seasonal parthenogenesis may be artificially aggravated into a more permanent dissociation by keeping up the particular excitants and the "nutritive optimum."

In juvenile parthenogenesis the aspect of retributive curtailment of the predaceous life is strikingly emphasised. *Miastor* and *Chironomus* exhibit ghastly examples of pædogenetic developments, of domestic cannibalism, and of exhaustive dissociation.

The alleged continuance of a species in total parthenogenesis is deceptive, owing to the all but imperceptible rate of dissociation, which nevertheless, if continued, must result in exhaustion of the species.

Wherever parthenogenesis has become a "confirmed physiological habit," symptoms of parasitic habits, impure associations, antitheses, "dwindling out of existence" of the males, and occurrence of yolk-glands are strikingly manifested.

The consideration of plant parthenogenesis shows that the same cause produces different symptoms in different equilibria. The female form is merely less unstable than the male. When a species degenerates to parthenogenesis it loses differentiation, and in accordance with the limitation of life thus entailed, expresses sex in one form only.

It is acknowledged that "the more intimate the parasitism, the more degenerate the sexual reproduction, and all trace of it is often lost."

The various fates of parthenogenetic ova are determined by retributive adjustment. The greater the degree of parasitism, the more is the male strain in course of diffusion.

Parthenogenesis, though not prejudicial to numbers, is acknowledged as "a handicapping of evolution." "Removal" of fertilisation is the result of retrogression rather than *vice versa.*

The more accentuated the parthenogenesis, the earlier the insulation of sex-cells takes place. An "extreme earliness in the embryonic separation of the germ-cells" is united with "a most precocious reproduction." All this supports my proposition respecting parasitic retribution under the stringent nature of reproductive requirements.

Parthenogenesis may be viewed as a case of more or less heterogeneous and malignant intra-cellular hermaphroditism.

The answer to the query: Why are internal parasites not parthenogenetic, like so many of their relatives? is contained in the fact that in their case there is too great a loss of teleological status to justify a more advanced arrangement of the division of the sexes.

CHAPTER VI

ASEXUAL REPRODUCTION AND ALTERNATION OF GENERATIONS

"Entre la mobilité et la conscience il y a un rapport évident."—HENRI BERGSON.

§ 1. Artificial Division and its Theories.
§ 2. Regeneration—Pathological and Physiological.
§ 3. Wide Occurrence of Asexual Process among Plants and Animals.
§ 4. Habitual Impregnation of Animals with Mineral Matter, and its Significance.
§ 5. Asexual Process comparable to Self-Fertilisation.
§ 6. Decline of the Fern.
§ 7. Nemesis of Pathological Forms of Asexual Propagation—Ruptures and Breakages—Overflow of Nutrition.
§ 8. Asexual Reproduction among *Cœlenterates*.
§ 9. Sluggishness and Dynamics.
§ 10. Plethora of Nutrition—the many-headed Bladder-Worm.
§ 11. Retrogressive Effects of Sea-Water.
§ 12. Satiety and Alternation.
§ 13. Sexual Links, "Nurses," and Parasitic Vicissitudes.
§ 14. Mosses and Ferns—Reproductive Predicaments.
§ 15. Alternations in Precocious Parthenogenesis.
§ 16. Insufficiency of former Metabolic Theories.

IN this chapter I am again driven to make considerable quotations from the admirable work of Professors Geddes and Thomson, since I do not know of any book which gives in so succinct and effective a manner the results of the extensive researches on this subject embodied in the recent literature of science, and it would be mere presumption on my part to attempt to do again what they have already done far better than I could do.

§ 1. *Artificial Division and its Theories*

"Weeping willows are by no means scarce trees in Britain, yet, as they never flower, they must all have grown from slips, or in other words artificial asexual multiplication. So, too, only more naturally, the Canadian pond-weed has spread prodigiously in our lochs, canals, and rivers, never flowering, but owing its increase wholly to the asexual process. Everyone knows how the gardener increases his stock by slips and cuttings, thus taking advantage of the power a part has to reproduce the whole. Quite in the same way, cultivators of bath-sponges bed out little fragments to keep up a convenient supply. In the last century, the Abbé Trembley delighted himself and others by the often-repeated observation, that to get many hydra polypes out of one, the simplest and quickest way was to cut it in pieces. Though the fragment be very small, it will reproduce the whole, provided always that it have to start with fair samples of the different kinds of cells in the body. The same may be done any day with the much larger sea-anemones. So the earthworm, curtailed by the spade, does not necessarily suffer loss, though it suffers pain. The head portion grows a new tail, and even a decapitated portion may reproduce a head and brain—not that this is saying much for these."

I have already hinted at the primitiveness of asexual reproduction, and referred to its frequent association with parthenogenesis. It thus frequently appears as a partial reversion to the mode of multiplication peculiar to the inorganic world, which some plants and a few of the lower orders of animals succeed in restoring by resorting to dissociative practices.

It is in crystallisation—towards which mode, according to Le Bon, normally all elements tend—where we see a kind of asexual growth specially marked. The plant that loses its sexual function of flowering is retrogressing towards the crystal. Atrophy of the male elements is but a previous step in the same direction. We have already seen that a crystal has more in common with organic beings than is commonly believed; the difference of life being, indeed, one of degree only.

It must, of course, be easier to "regenerate" when there is very little in the shape of potential differentiation to reproduce. Thus, whilst under the generally prevailing conditions of asexual propagation a frequency of reproduction is (retributively) indicated, the difficulties of refashioning what previously existed are not very great. It is very elementary construction; even head and brain, as the foregoing passage indicates, do not count for very much.[1]

---

[1] One might say that under predominant retrogressive influences it is easier for an organism to reproduce its kind by discontinuous growth than to continue in the direct line of effort conducive to maintenance and fortification of teleological status.

§ 2. *Regeneration and Moulting—Pathological and Physiological*

"Spades and knives are not exactly instruments of nature, but they have their counterparts. Fighting with a rival, a crab may lose its claw, or the same may happen in *the frequently fatal moulting, which seems almost like a mistake in nature.* Slowly, however, forgiving nature makes good the loss; the cells of the stump multiply, and arrange themselves in obedience to the same necessities as before, and a limb is regenerated. Many an appendage among the lower animals is from time to time nipped off, only to be grown again. A snail has been known patiently to regenerate an amputated eye-bearing horn twenty times running. Sometimes one is tempted to think that the animals almost understand that it is better for one member to perish than for the whole life to be lost, so readily does a starfish surrender an arm, or a lizard its tail. Yet it must be recognised that animals, like men, are often wiser than they wot of. In the panic of capture, strong convulsions may occur, which surprise and perhaps shock the molester of a sea-cucumber by the ejection of its viscera; or a tetanic contraction of the muscles makes the slow-worm brittle in the hands of the captor. The power of regeneration is most marked in echinoderms, but persists as high up as reptiles. The regrowth of part of a lizard's leg is the *chef-d'œuvre* in this line. Beyond that, regeneration is restricted to little things. We constantly regenerate the skin of our lips, but we cannot naturally replace an amputated limb. It is more marvellous that we cannot, than that the lizard can. That the cells of an irritated stump should divide and multiply, and that the result should be the same as it was at the first, is really no marvel, or rather as much as, but no more than, the original development. The dividing cells of the growing stump are simply repeating their original development."

This passage very prominently introduces the pathological factor in the shape of moulting—"frequently fatal" and "almost like a mistake in nature."

However, it is only the stage of reconvalescence that is mooted, and no attempt is made to describe the history of the inception of the disease and its subsequent course. Metaphorical language has to be introduced to cover the same gap that we previously and variously saw marked by the words "bias" and "diathesis."

Moulting, however, is inseparably connected with pathological processes which have to be fully traced out.

On the point of physiological regeneration, Professor Weismann tells us in his *Germ Plasm*: "If we consider how highly important regeneration is from a physiological point of view, its wide and even general distribution in the animal kingdom need not surprise us, and we shall be able to understand why it has been introduced even into the course of normal life: for the functions of certain organs depend on the fact that their parts continually undergo destruction, and are then correspondingly renewed. In this case it is the process of life itself, and not an external enemy, that destroys the life of a cell. I refer, of course, to the process of physiological regeneration.

Our knowledge of histology is not yet sufficient for us to be able to determine what tissue-cells in the higher animals become worn out by use during life, and have therefore to be continually replaced; but it has been proved in many cases that the wearing away of the cells goes on incessantly, and that life could not last if these cells were not constantly replaced. Such a constant loss and renewal of the cells occurs in the cases of the epidermis of the higher vertebrates, the human finger-nails, the blood-corpuscles, hairs and feathers, claws and hoofs, the epithelial lining of the respiratory and other passages, and even in the antlers of stags. In all these cases a continual or periodic wasting away or shedding of groups of cells occurs normally, and a corresponding replacement of these cells is one of the normal functions of the body, and is therefore provided for."

Regeneration thus illustrates the point of view of teleological adjustment. It is not an external enemy, but the "process of life itself," that destroys the life of a cell. "Natural Selection" breaks down, and for want of a better explanation the "mystery" of life is here invoked. I have already pointed out that it follows from a due consideration of physiological and morphological development that the fate and duties of individual cells or groups of cells, as well as status and extermination, are all alike teleologically determined. Failing such an explanation, however, Professor Weismann indulges in the following conjectures regarding the powers of growth and survival of a cell: "It must be assumed that the reproductive power of a cell is regulated by the idioplasm, because the power and rate of multiplication are essential qualities of a cell, and, as we have seen, are controlled by the nuclear substance. But we cannot at present even form a conjecture as to which qualities of the idioplasm the degree and rate of the capacity for reproduction are due. We must be satisfied with attributing to the cells which form the epidermis of the embryo an idioplasm possessing a definite reproductive power,[1] which gradually decreases. We can further only suppose that the idioplasm retains its constitution during life, or, in other words, that the determinant of a particular part of the epidermis is always retained in the permanent stock of young cells. Regeneration depends simply on a regular increase of those cells which contain epidermic idioplasm."

The least that becomes apparent is, that the biological outlook, as presented by Professor Weismann's theories, is too narrow and too local to satisfy the wider concepts of life which are now beginning to emerge.

§ 3. *Wide Occurrence of Asexual Process among Plants and Animals*

We are told that: "In plants, as one would expect from the typical vegetative constitution, the asexual process is common, particularly among the lower forms. The most familiar of all cases is afforded by the common liverworts (*Marchantia* and *Lunularia*), which, through the formation of asexual buds or gemmæ in the cups so familiar upon their thallus, are enabled to overrun our flower-pots, and so rapidly become a pest of the greenhouse. Many ferns too, notably among the Aspleniums, reproduce by bulbils, arising upon the frond; and the bulbils which arise in the axils of the leaves of the tiger-lily are familiar missiles for every child accustomed to a flower-garden.

---

[1] That is: Why does the epidermis reproduce?—because it is possessed of reproductive power!

"The Alliums, and some of our common grasses also, furnish us with examples of the replacement of flowers by separable buds. Asexual reproduction or multiplication by more or less discontinuous growth, without the differentiation of special and mutually dependent sex-cells, occurs from the simplest animals on to the tunicates or sea-squirts, from the base to just over the line which separates backboneless and backboned animals."

It is not a little remarkable that echinoderms, in which the "power of regeneration" is very accented, are all known for being more or less loaded with inorganic calcareous matter and more or less vermiform and disc-like in appearance. The very names suggest it. There are stone-lilies, sand-stars, sea-urchins, and starfishes. In some, calcareous particles are scattered here and there; in others, the very skeleton consists of calcareous matter; frequently there are calcareous plates or rods, etc.

§ 4. *Habitual Impregnation of Animals with Mineral Matter, and its Significance.*

As regards the accumulation of mineral deposits in the bodies of animals, Professor E. H. Starling points out, in *The Fluids in the Body*, that "a mass of protoplasm will tend to absorb from the surrounding medium and to concentrate in itself all those substances which are more soluble in the colloidal system of the protoplasm than in the surrounding fluid. This process of absorption may be carried to a very large extent if the dissolved substances meet in the cell with any products of protoplasmic activity with which they may form insoluble compounds, since they are thereby removed from the seat of action. By such a process as this we may account for the accumulation of calcium or silicon in large quantities in connection with the bodies of various minute organisms."

In any case, however, all absorption must depend on the "combining affinities" that "have been set free in the cell," and these in their turn, of course, must depend on nutritional habits. Thus Professor Starling states that "the physical permeability of the cell-skin is a necessary condition for the privacy of the cell-metabolism; but it does not prevent the cell taking up from the surrounding medium any constituent which is lacking to restore the constitution of the protoplasm to the normal."

We are further told in the same valuable treatise: "A great step in evolution was taken, therefore, when the organism secured for the majority of its cells a medium of uniform composition by the formation of a body-cavity or cœlom and the enclosing in this cavity of a fluid not differing widely at first from the surrounding sea-water. This step was typical of the whole course of the evolution which results in rise of type. Even at the present time the position of a man among his fellows, or of a man among other animals, is indicated by the extent to which he is able to create his environment and to keep it adapted to his special needs, so that he may never experience directly the numerous adverse influences which are present just outside his own self-created circle. Every slight deviation of an ocean current, every spell of cold weather, brings about the sacrifice of myriads of living beings, which are unable to withstand the trifling changes of saline concentration or temperature thereby induced in their surroundings. The evolution of a cœlom was followed by the appearance of circulatory and other organs designed to maintain the composition of the internal medium constant at all parts of the organism, under varying internal conditions. In the highest vertebrata, the evolution of a thermotaxic mechanism has provided for the maintenance of a constant temperature in this medium, whatever may be that of the surroundings, and in ourselves practically all the day's energies are devoted to the fashioning of an environment independent of climatic influences, and fitted in every way to maintain our functional capacities at their highest possible level."

Rise of type we thus find again largely founded in adaptive response, mainly of a nutritional order, with gradual advance of physiological status, whilst extermination is determined by lack of response, by fastidiousness (physiological isolation), and backwardness of nutritional and, hence, physiological status.

Here again we see that undue accumulation of foreign (mineral) deposits in an organism must be set down to illegitimate nutritional adaptation, which we have already found to be responsible for pathological developments and for precariousness of life generally. Impregnation of animals with mineral matter is an adaptation which is not productive of rise of type, and when we find Professor Starling remarking that "the one common feature of all cell activity is adaptation," it becomes necessary to add that a special investigation into the physiology of each case is required to determine the progressive or retrograde character of the adaptation. Adaptation *per se* is no criterion of healthy development any more than is Darwinian "usefulness." The teleological test which I have indicated, however, renders a needed discrimination on these matters possible.

§ 5. *Asexual Process comparable to Perpetual Self-Fertilisation*

We may now reasonably conclude that in the asexual process all manner of internal self-fertilisations and hybridisations, abhorred by nature, are resorted to.

These intercellular unions, however, are so loose as to leave residues or "surpluses" for "regenerations" of the same loose character. The quality of structure in these regenerations is thus too unsatisfactory for higher organisms to indulge in such modes. Dr Beard, who has recently made some important researches into the mode of development of vertebrates, concludes that "harmony and law reign in the reproductive life of Mammalia." He believes that vertebrate development takes place by means of an antithetic alternation of generations, in which an asexual generation is followed by a sexual generation—in the higher animals the asexual generation being generally a very poorly developed structure, and the sexual generation far more complex and highly differentiated. At the "critical stage" when the embryo begins to put on its general and specific characters, it also sets about the task of suppressing the larval foundation.

Again, we may conclude that ascent in evolution means a gradual surrender of physiological confusion, and of habits spelling liability to pronounced pathological states. We are strikingly reminded of these facts when we find Dr Beard pointing out that one form of cancer is due to an "irresponsible" asexual generation or growth occurring during the sexual generation period of the life-cycle; and that to operate for the "cure" of cancer is unnatural and is a mistake, because an asexual generation tends to grow the faster when it is cut. It is evident that the asexual mode represents a projection of dysteleological forces making for retrograde and less stable equilibrar rearrangements, if not for pronounced disease.

The apparently wonderful powers of propagation exhibited by grass, liverwort, pond-weed, and fern must be held to be associated with dissociation. In spite of the imperceptibility of the dissociative processes, however, there can never be a mistake as to the loss of survival-capacity.

§ 6. *Decline of the Fern*

The decline of the fern supplies a good example of the dissociative nature of prolific asexual reproduction and consequent loss of teleological status.

As regards the fern, it is said that "the smaller forms like the Selaginellidæ and the club-mosses were represented in the past by plants of much greater size, as is seen from fossil remains, and it is probable that the modern forms have descended from these giants" (*Evolution by Atrophy*, Demor, Massart, and Vandervelde).

Alternation of generation is most clearly exhibited by the fern and the vascular cryptogams generally. Structurally, there are many features of backwardness. In the fern the stem is mostly a rhizome. These rhizomes grow either horizontally or obliquely upwards through the soil. The rhizome is mostly polystelic, under which arrangement the steles are not so strongly developed as is the single stele of the typical monostelic forms. "They are simply concentric masses of vascular tissue, surrounded by pericycle and endodermis."[1]

---

[1] It has been said that "the uses of ferns bear a small proportion to their numbers in the vegetable kingdom." How very true is it thus again that teleo-

There is thus decided vascular and anatomic backwardness from a diagnostic point of view.

§ 7. *Nemesis of Pathological Forms of Asexual Propagation—Ruptures and Breakages—Overflow of Nutrition*

Again we have not a far cry from abnormality of function to the nemesis of reproduction in the domain of asexual propagation.

The mechanical ruptures and breakages, like those in Schizogenes, are familiar; but breakage also occurs "in a few of the relatively high infusorians."

"That the breakage sometimes means dissolution is certain; nor is reproduction ever so very far removed from death.

"The rupture becomes orderly and systematic in budding. This may be multiple, as in the common Arcella, where a number of small buds are constricted off all round. But the process is oftener concentrated in one extrusion or overflow. In budding, the separated daughter-cell is in varying degree smaller than the parent, and the process resembles an overflow."

This remarkable overflow is due to the fact that the metabolic ratio is obscured by the presence of a large proportion of inorganic matter, the result of which is

logical factors, numbers notwithstanding, are the real determinants in evolution; and how well is the teleological rationale (biological and cosmic usefulness, which is by no means always the same as the apparent and immediate usefulness which has usually been looked for hitherto) of survival hinted at by the Scriptural saying that, "Every tree that bringeth not forth good fruit is hewn down, and cast into the fire."

the predominance of a chemical diathesis, which induces a pathological condition in the organism.

The orderliness of ruptures in budding indicates, again, that definite necessities occur in all cases of propagation and disaggregation.

In discussing these ruptures in budding the authors say : "The nucleus almost always shares in them in an orderly and deliberative fashion." "Gruber has been especially successful in proving that fragments of Protozoa, artificially separated without nuclear elements, cannot live long, though they may grow and repair their losses for a little. The nucleus is essential to life, though sometimes it seems to disappear, and become as it were a diffuse precipitate in the protoplasm."

The nucleus is thus generally associated with the ordering principle, and its occasional apparent disappearance is symptomatic of the diffusion of the higher forms of sex under conditions favouring dissociation and amorphism.

"The divisions may also be multiple, taking place in rapid succession and in limited space, *e.g.* within a cyst. Then we speak of spore-formation. The last three modes of multiplication are exceedingly common among Protozoa."

"In sponges no one can fail to recognise the impossibility of drawing any rigid line between growth and asexual reproduction. Between simple extension of the parent mass, and the budding off of new individuals, no sure distinction can in many cases be made out."

The ghastly acceleration of growth among Protozoa, with a proportionate limitation of environment and of life—a general retribution—is thus strikingly apparent. Sponges, it appears, represent a kind of intermediate equilibrium, the higher form of sex being diffused under a nutritive overflow.

As a consequence they have to resort to the expedient of "multiple union" in order to preserve the species.

"In the fresh-water sponges, in disadvantageous circumstances—of cold in some countries, heat and drought in others,—some of the cells club together to form gemmules, which often save the life of the otherwise dying sponge. They are complex enough with sheaths and spicules, and sometimes even with a float, but in principle they simply do by a multiple union what is otherwise attained by ovum and sperm. Best known in this respect is the fresh-water sponge (*Spongilla*); they have also been described in other common sponges, *e.g.* in *Clione*, the borer in oyster shells."

I would rather say that "disadvantageous circumstances" are tantamount to a reduction of the nutritive excess, and thus restore—as *vide* the fasting Rhine salmon—a healthier margin of sexual potential.

§ 8. *Asexual Reproduction among Cœlenterates*

But it is in the case of the Cœlenterates and their colonies, where we find the most startling cases of a reversion to primitive modes of propagation.

"In such names as zoophytes, sea-firs, sea-roses, there is a prevision of the undoubtedly plant-like character of many of the cœlenterates. A sessile habit is very general, though often only a phase in the life-history, and *asexual reproduction runs riot.* A well-fed hydra is prolific in bud-bearing; and numerous gradations connect this with the myriad colonies exhibited by many hydroids. The individuals forming a united family share in the common life and nutriment. As the colony becomes complex, it is often physically impossible for all the members to remain on terms of even approximate equality of internal and external conditions. One becomes relatively overfed, another starved. Slight differences of function gradually become emphasised and exaggerated till division of labour is established. The structural aspect of this is differentiation or polymorphism among the members of the colony, and results in the establishment of nutritive and reproductive, sensitive and protective 'persons.' Thus in the common Hydractinia the open-mouthed nutritive individuals are markedly contrasted with the dependent reproductive persons; and again, in different form, the rhythm repeats itself in the contrast between active, offensive and sensitive elongated members, and entirely passive and abortive spines, which form a *chevaux-de-frise* under shelter of which the others cower. It is usually supposed that the sessile hydroids are in a sense degenerate from more active ancestral types. The free-swimming embryo becomes exhausted, settles down, and exhibits predominant vegetativeness with postponed sexuality. In many cases, however, this is a recovery of the ancestral liberty of action, for modified 'persons' are set adrift, as active, free-swimming, sexual medusoids."

What a strange picture is here presented! We have a society actually founded on unstable equilibria, on predominant sessile, impure, and parasitic propensities. From the very inception of the colony the principle of division of labour is distorted. How could there be social justice? The very possibility of an even approximate equality is precluded. The whole social organism, structurally as well as politically, presents an entire lack of symmetry.

Polymorphism, which in this case amounts to the surrender of individuality without any compensating advantage through greater social justice or generic advance, marks the nemesis of the degenerate cœlenterates. It is a case of retrogression rather than evolution. No wonder even the free-swimming embryo soon becomes exhausted. What residue of vitality can there be in the colony under the additional exhaustion of an intra-organismal struggle?

The establishment of division of labour is here wrongly depicted as taking place when exaggeration has become extreme. This is on a par with the usual blunder of taking the final eruption—the crisis—of a disease for the real disease itself. No wonder there is a confusion as to when genuine division of labour ends and intra-organismal anarchy sets in.

Again, we read of a medusoid possessed of no less than nine stomachs—what an example of expediency for our epicureans! It is assumed to be "highly nutritive"; and when we consider its reproduction, it is obviously well on the way towards a process of rectangular "incomplete division."

"There are, however, active forms of the true medusoid type (*Trachymedusæ*) which never descend to the sessile nadir of existence, but yet exhibit the asexual tendency of the class in forming temporary clusters of pendent buds. Lang has lately described a remarkable compound medusoid (*Sastroblasta raffaelii*), which has sometimes as many as nine stomachs, and may be assumed to be highly nutritive. The remarkable point, however, is that the compound adult is the result not only of continued budding, but of a process of rectangular incomplete division. Along with some others it leads on towards the Portuguese man-of-war or siphonophore series. Here the larva develops at first into a simple medusa-like individual, but this buds off a manifold series of 'persons,' which, by dislocation or even migration, become arranged in all the beauty of the siphonophore colonies, which surpass even Hydractinia in their division of labour. It is difficult enough in some cases to distinguish between true 'persons'—which Haeckel calls 'Medusomes'—and mere organs like protective bracts, which are also budded off."

The rectangular incomplete division alluded to not inappropriately recalls inductive "budding" in the phenomena of disaggregating matter.

"There remain two classes of cœlenterates—the Ctenophora, like *Beroe*, which represent a climax of activity, and never divide; and the Actinozoa (sea-anemones and corals), which lead to a passive terminus again, and exhibit profuse asexual multiplication. A few sea-anemones divide normally, just as they may by artificial cutting. Fragments may also be given off in an arbitrary sort of fashion, reminding one of the overflow buds of sponges. The division may be either longitudinal or crosswise in sea-anemones, and the budding of corals takes many forms, resulting in the quaint complexity of brain-corals and the like. In one sea-anemone (*Gonaclinia prolifera*), where transverse division occurs, it is interesting to notice that this has only been observed in young forms with undeveloped sexual organs. It recalled, in fact, the asexual multiplication of a young jelly-fish. In another of the corals (*Antipatharia*) Brook has recently observed how a nutritive 'person' may by constrictions form a reproductive individual on either side."

§ 9. *Sluggishness and Dynamics*

In *Nutrition and Evolution* I have already spoken of generic activity as being somewhat of the nature of the quantity v in the dynamic term $\frac{1}{2}mv^2$, expressing the kinetic energy of a body as half the product of its mass into the square of its speed.

A growing sluggishness and sessile habits—a decay of v—may for a time be supported by an increase of m—importations and external stimuli.

Those external stimuli, however, frequently produce an artificial re-stimulation of v through dissociation. Although such stimulation must finally result in a distortion of polarity and a loss of teleological status, it may for a considerable time impart a kind of fictitious activity to an organism, which explanation would sufficiently account for the fact that certain types showing very degenerate forms of reproduction are yet outwardly characterised by activity of movement.

In *L'Evolution Créatrice* Professor Bergson, whose philosophy is largely based on recent biological science, has the following passage: "Mais la fixité, chez l'animal apparaît le plus souvent comme une torpeur où l'espèce serait tombée, comme un refus d'évoluer plus loin dans un certain sens : elle est proche parente du parasitisme et s'accompagne de caractères qui rappellent ceux de la vie végétale." Sluggishness and immobility in an animal are based on lack of response and on previous susceptibilities. They are equivalent to parasitism, for they imply the losing game of animal metabolism, *i.e.* physiological indolence, with consequent degeneration—loss of the nutritional and, hence, morphological value of functional activity ("die ernährende Wirkung des functionellen Reizes")—and cessation of work, with consequent loss of teleological usefulness and of the animal's true relationship to the world of life.

§ 10. *Plethora of Nutrition—The Many-headed Bladder-worm*

In the case of worms it is noteworthy, again, that the "asexual reproduction takes place in favourable nutritive conditions, and as each individual exceeds its normal limit of growth."

Further, and as already mooted, we now come across the "prolific multiplication characteristic of the flukes and tape-worms. The common liver-fluke has often several asexual generations before it finds its final host in the sheep, and is surpassed in this respect by some of its relatives. The bladder-worm, *in passive ease with a plethora of nutrition*, may form asexually many "heads," each of which, inside a future host, grows out into the long series of joints which compose the tape-worm. In their profuse asexual multiplication these parasites are like parasitic fungi, but unlike them in the retention of the sexual process to boot."

Parasitism is thus seen to be the universal associate of retrogression. It provides a veritable "*malorum immensa vorago et gurges.*"

§ 11. *Retrogressive Effects of Sea-Water*

In the water, a facility of nutrition similar to that of the interior parasite, which is bathed in "nutritive fluids," frequently obtains, although with very differing degrees of activity and adaptation.

The effect of salt water in causing retrogression, and the enormous quantities of impurities it contains, all favour the development in organisms of a nutritive diathesis, *i.e.* of abnormal nutritive habits. "There is no doubt," says Professor Starling, "that the relative solubilities of the absorbed substances in the cell *and its surroundings respectively* must play a part in the process of assimilation, at any rate by lowly organised cells, and still more in the intra-cellular exchanges involved in the processes of secretion and excretion." The door is thus easily opened for distortions of protoplasmic discrimination, and for changes of habits and disturbances in a retrograde direction.

"In the tunicates the asexual process has again full play. It is not confined to the passive sessile forms, where one might expect it, but occurs in some of the free-swimmers as well. From a creeping stem buds may arise, like plants from a rhizome; or a parent form may bud off all round, and finally die away, leaving the offspring in a circle round a cavity. Both by budding and division chains may be formed, as in the salpas. In these lowly vertebrates asexual multiplication terminates."

Here again we have the association of the aquatic habitat with dissociation and degeneracy.

The retrogressive physiological effects of salt water on plant and animal tissue are matters of observation; but Le Bon has reminded us of other physiological effects of impurities which have been frequently observed, although their effects are far from being duly appreciated.

§ 12. *Satiety and Alternation*

"Asexual reproduction, from continuous budding to discontinuous multiplication, has many degrees, leading on to the sexual process." The alternations frequently proceed in regular rhythm. Normally, as in many phases of hermaphroditism and self-fertilisation, a psychological factor of satiety, often in conjunction with some outer corresponding rhythm in nature, would seem by producing alternations to impose a check upon over-indulgence. Even these correlated and regulating factors, however, are frequently rendered nugatory by parasitism.

In alternation of generation we behold a diffusion of the nutritive overflow over several succeeding generations under conditions which change rhythmically and subsequently produce modifications of polarity. In extreme cases of overflow individuality itself appears dissociating and diffusing in conformity with inner nutritional and sexual vicissitudes and the distortions of polarity.

"A fixed asexual hydroid buds off and liberates locomotor sexual swimming-bells, whose fertilised ova give rise again to hydroids. Asexual and sexual generations alternate."

"Thus we get offspring never resembling its parent, but which itself brings forth a progeny that returns in its form and nature to the parent."

"Or take, in slight contrast, the life-story of the common jelly-fish *Aurelia.* Large free-swimming sexual animals produce ova which are fertilised by sperms; the embryo develops, not however into a jelly-fish, but into a sessile hydroid-like organism or 'hydra-tuba.' By growth and division this asexually produces the jelly-fish in turn. Here the sexual generation is more stable and conspicuous, the reverse of the former case, but the same formula applies."

"Or take a case from another class of animals, the marine worms. Some of the syllids have the following life-history. A worm remains asexual, never attaining either the external characteristics or the internal organs of the sexual individuals. It gives rise to these, however, by an asexual process of chain-making. Sexual individuals are budded off from the asexual, into which their fertilised ova in turn develop. This must, of course, be distinguished from cases where asexual multiplication is only a phase preceding the acquisition of sexuality.

"In the *Doliolum* we have several asexual generations between the sexual."

"From a fertilised ovum a nurse, or asexual individual, develops as before. This produces a number of primitive buds, which cluster about the nurse. Many of them form nutritive individuals, and these we may leave alone. But others become 'foster-mothers,' and go free, carrying with them a few of the primitive buds—as it were, their younger sisters. The foster-mother remains asexual, is a bearer merely, and need not further complicate the series. But the primitive buds which have been carried away give rise asexually to secondary buds; these become sexual, and their fertilised ova give rise to the original 'nurse' forms."

§ 13. *Sexual Links, "Nurses," and Parasitic Vicissitudes*

The introduction of the sexual link is in all cases dependent on a previous reduction of the nutritive overflow, the overfed asexual units or "nurses" being incapable of the physiological labour required by sexual propagation.

"Vague as the boundary must be," we are told that from the above instances must be distinguished the alternations "between sexual and degenerate sexual reproduction"; and now, so far from being made acquainted with a kind of neutral zone, in a trice we find ourselves plunged into the most extreme exaggerations of parasitism, with its dire results.

"The adventurous history of some of the flukes (Trematoda) may be taken as a first illustration. The common liver-fluke (*Distomum* or *Fasciola hepatica*), which causes the disastrous 'rot' in sheep, has a life of vicissitudes. The fertilised ovum gives rise to an embryo, which passes from the sheep, which its sexual parent infested, to the water by the field side. There it leads for a while an active life, knocking against many things, but finally attaching itself to a minute water-snail. Into this it bores, losing its covering of active cilia with change of habit, and becoming much altered into a passive vegetative form known as sporocyst. Now this sporocyst sometimes divides; and if this were all, and the results grew up into liver-flukes, we should have the old formula and less loss of sheep. But direct development never occurs, and we may leave the casual division at present out of account. Certain cells within the sporocyst form germs, and these serve in the place of genuine ova. They produce within the body of the sporocyst another brood of what are called *Rediæ*. There may be several generations of them, and the final result is a brood of minute tailed organisms (*Cercariæ*), which leave the water-snails, leave the water even, creep up grass stems, and encyst themselves. There most wait for death, a few for the attainment of adult sexual life if they chance to be eaten by a sheep. The somewhat complex story may be written in lines:—

The fertilised ovum gives rise to an aquatic embryo (1).
This enters a water-snail, and becomes a *sporocyst*. (The sporocyst may divide.)
Within the sporocyst, cells develop into *Rediæ* (2)
There may be several generations of rediæ (3, 4).
The last generation (*Cercariæ*) may become adult sexual liver-flukes (5).

"This cannot be accurately ranked as parallel to what occurs among the above-mentioned tunicates, for the *Rediæ* arise from precocious reproductive cells. These cannot be called ova, and there is no fertilisation, but yet the process is not one of division or of budding. It is a degenerate process of parthenogenetic reproduction in early life.

"The germ-cells, which behave like ova, and yet do not rise to that level, appear sometimes in a central mass within the asexual division, sometimes simply in the epithelium lining the body-walls. There may be a long series of generations producing and produced in this way, and these are often unlike one another. Fluke, embryo, sporocyst, rediæ, and cercaria, are all markedly different in structure, though embryo changes into sporocyst, and cercaria into fluke."

General precariousness and curtailment of life and a vicious round of metamorphoses are the glaring features characterising all the above pædogenetic developments, no matter what form they take. The retributive effects of parasitism could not be more strikingly manifested.

§ 14. *Mosses and Ferns—Reproductive Predicaments*

Among plants, the ferns and mosses are typical examples of alternating metamorphoses.

"This alternation between sexual reproduction with the usual fertilisation and reproduction by means of special cells which yet require no fertilisation, prevails in many plants, *e.g.* ferns and mosses. From a fertilised egg-cell the ordinary fern-plant, with which everyone is familiar, develops. But this is quite asexual, if we mean by that that it is neither male nor female, and that it produces neither male nor female elements. At the same time it produces special reproductive cells—not egg-cells exactly, any more than those within the sporocyst were, but yet able to develop of themselves into a new organism. This is not another fern-plant, however, but an inconspicuous green organism, much less vegetative, and sexual. The so-called 'spore' formed on the leaves of the sexless fern-plant falls to the ground, develops a 'prothallus,' which bears male or female organs, or both. An egg-cell is fertilised by a male element, and the conspicuous vegetative fern-plant once more arises."

In the formation of the prothallus the fern reverts to a state similar to the lower group of Thallophyta—Algæ and Fungi. The prothallus is an independent plant. By means of its chlorophyll it can assimilate the carbon dioxide of the air, and by the aid of the root-hairs it absorbs nutritive salts from the soil. It is a distinct self-sustaining plant, whose vegetative body is a thallus. The prothallus is usually hermaphrodite, but dichogamy prevails; it generally produces but one embryo, and then dies.

I have already referred to the degeneration and the decline of the fern. Only by modifications of a reductive nature can this degenerate form achieve sufficient reproductive power for true breeding. In the "sexless" fern-plant the functions of sex and nutrition are abnormally proportioned, and this inhibits true breeding. The production of the spore is a mere expedient to restore a better balance, inasmuch as the spore, detached from the parent and therefore thrown upon its own resources for sustenance (which it now derives from the soil and air), develops in a normal and healthy manner, and can therefore return to the higher form of reproduction by means of sex.

This teleological recovery is purchased, however, at the expense of survival-value, for the reversion to spore-production implies an indirect and uneconomical (dysteleological) mode of achieving reproduction. The generations of the fern are thus at a relative disadvantage as regards survival.[1]

"Now take the history of a moss. Unlike the fern, the more conspicuous 'moss-plant' is sexual. It bears male and female organs, and an egg-cell is fertilised by a male element. The fertilised egg-cell, however, does not lose its hold of the mother-plant, but grows like an encumbering parasite upon it. Obviously, then, it does not give rise to another 'moss-plant.' The result of the fertilised egg-cell is a tiny sexless stalk, which bears on its apex the special reproductive cells or spores with which we are now familiar. In other words, the fertilised egg-cell develops into a parasitic spore-bearing generation. The 'spores' fall into the ground, as they did in the fern, and there grow into a usually thread-like structure, from which the sexual moss-plants are budded off."

---

[1] In *Nutrition and Evolution* I have made a reference to the combined physiological and œcological factors of plant-life as they affect teleological status and survival. I have endeavoured to show (pp. 209–10, 242–7, 278–9) that evolution of sex and rise of type are intimately associated with the perfecting of organs which effect the extrusion of pathological material, and, further, that the accelerated and irregular growth by which relatively low types are frequently characterised is responsible for reproductive wastefulness, with consequent low quality of type both economically and teleologically considered. It was also pointed out that backwardness of this kind involves inferiority as regards prepotency and resistance to disease. I have specially alluded to the case of the Coniferæ (many of which fail to "clean" themselves) and to their inferiority as compared with dicotylous trees. In this connection it is worthy of note that Professor Percy Groom has found that "evergreen Coniferæ have a larger number of serious fungus and insect foes than have dicotylous trees in North-Temperate regions. He also draws attention to the fact that complete defoliation, especially if repeated once or twice, of an evergreen conifer by insects, fungi, or other agencies, leads either to the death or serious weakening of the tree; whereas a deciduous dicotylous tree may suffer defoliation regularly each year and continue to exist. In this respect the larch, being deciduous [showing an annual fall of leaves], rather resembles the deciduous dicotyledon, for repeated partial defoliation by the larvæ of the Larch Leaf Miner (*Coleophora laricilla*) does not cause its death" (*Knowledge*, vol. xxxiii. No. 505, August 1910). I might add that the larch in the light of the tests previously laid down appears superior to other Coniferous trees.

Here once more we have an instance of reproductive nemesis which can only have been produced by dysteleological metabolic modes.

We see that only from the thread-like overflow portion—*i.e.* at the point of return to a healthy physiological order—may the species be regenerated.

"In the fern, the vegetative sexless generation was the more conspicuous; in mosses, the sexual generation."

We may conclude that both types are at different stages of dissociation, with widely differing ancestral dynamics. A little later we are significantly told that "the origin in each particular case is involved in the pedigree of the organism. Thus Haeckel distinguishes a progressive from a retrogressive origin; in the former, the organisms are in transition from preponderant asexual to sexual reproduction; in the latter, the organisms are returning or degenerating from dominant sexuality to an asexual process. It is *safe to say that the latter* is *more frequently the right interpretation of the facts.*"

§ 15. *Alternations in Precocious Parthenogenesis*

Different kinds of alternations may be combined in a more complicated manner. To instance one case: "In some flies precocious parthenogenetic reproduction alternates with the normal sexual reproduction of the adults."

Again, "in many insects and crustaceans, parthenogenetic reproduction alternates with the normal sexual process. There may be one or many intervening parthenogenetic generations."

"The rhythm may be followed in yet a higher scale. In a very few cases there is an alternation between two different sexual generations. Thus one of the thread-worms (*Leptodera appendiculata*) found in the snail gives rise, by the ordinary sexual process, to a different form, which leads a free life, and subsequently gives origin to the parasite. In both generations the sexes are distinct. More remarkable still is the history of another nematode (*Angiostomum nigrovenosum*), found in the lung of the frog. It is physiologically hermaphrodite, though its organ is ovary-like; its eggs are fertilised by its own sperms, which mature first; the progeny become sexual—males and females—in the earth, and their offspring return to the frog, where they become hermaphrodites. Another example of alternation of sexual generations is found in one of the thread-worms which occur in man (*Rhabdonema strongyloides*)." Thus again we have a ghastly round of perversities.

§ 16. *Insufficiency of former Metabolic Theories*

Generalising on their descriptions of alternation of generation, Geddes and Thomson assure us that :—

"A consideration of the physiological distinctions between the asexual and sexual generations, shows that the former is the expression of favourable nutritive conditions resulting in vegetative growth, or at most in asexual multiplication, while the latter is conditioned by less propitious circumstances. Just as a well-nourished plant may continue propagating itself by shoots and runners, and just as an aphis in artificial summer may for years reproduce parthenogenetically, so a hydroid with abundant food and otherwise favourable environment may be retained for a prolonged period vegetative and asexual, while dearth of food and otherwise altered conditions evoke the appearance of the sexual generation. The contrast between the deeply-rooted, well-expanded fern-plant and the weakly-rooted, slightly-exposed prothallus, is obviously that between an organism in conditions favourable to the continuance and preponderance of anabolic processes, and an organism in an environment where katabolism is, at an early stage, likely to gain the ascendant. The former is thus naturally asexual, the latter sexual. A survey, in fact, of the conditions and characteristics of the two sets of forms, inevitably leads us to regard the asexual generation as the expression of predominant anabolism, and the sexual as equally emphatically katabolic. Alternation of generation is, in fact, a rhythm between a relatively anabolic and katabolic preponderance." This explanation of the asexual phenomenon, however, is inadequate and of too verbal a character. It lacks the precision of a standard. What, in fact, is the norm of metabolism and rhythm? When have we got undue preponderance?

I have now sufficiently shown, however, that every indication of antithetic development—as that so markedly distinguishing fern and prothallus—must be regarded as a serious symptom of a perversion of normal metabolic ratios, and that our criteria must be founded on a teleological rationale.

SUMMARY

Asexual propagation frequently represents a reversion of reproductive phenomena in the direction of inorganic modes. This limitation of life is conditioned by habitual assimilative abuse. Rapid—though often fatal—regeneration is possible in view of the lowliness of the respective organic equilibria.

Regeneration illustrates the point of view of teleological adjustment, as I have tried to establish it.

The power of regeneration is most marked in Echinoderms.

The common liverworts under so-called "favourable conditions" become a pest of the greenhouse, which illustrates the dissociative character of their propagation.

Physiological adaptation, as evinced by the study of osmotic relationships of cells, is largely a matter of assimilative habits and of response. Habitual impregnation of organisms with mineral matter does not produce an adaptation conducive to rise of type.

The ill-effects of the asexual process are comparable to those of perpetual self-fertilisation.

The case of the fern illustrates the gradual loss of survival-value where organic dissociation has occurred.

Ruptures and breakages—often fatal—constitute a conspicuous nemesis of extreme asexual propagation. Striking, *i.e.* undue, acceleration of growth is evidenced by the expedient of spore-formation, exceedingly common among Protozoa.

In sponges the nutritive overflow is such that the organism is obliged to resort to the expedient of multiple union. Among cœlenterates asexual reproduction is frequently seen to run riot, and this under predominant sessile and parasitic propensities, as witness the "well-fed" *Hydra* and the hydroid colonies with their chaotic polities. *Sastroblasta raffaelii*, with nine stomachs, exhibits "rectangular incomplete division," which is the analogue of defective ovum-segmentation and is likewise diagnostically significant. The many-headed bladder-worm with "a plethora of nutrition" represents an extreme case of asexual reproduction, concordant with its intense parasitism. The tunicates illustrate the retrograde and dissociative effects of salt water and of impurities generally. Life in the sea easily leads to distortions of osmotic adjustment, especially with lowly organised types.

Alternation of generation means a diffusion of the nutritive overflow over several generations under changed conditions, and subsequent alternate modifications of polarity. The extremes are again entirely supplied by parasitism, as witness flukes and rediæ and their vicious round of metamorphoses.

The reproductive predicament of the fern is such that only by modifications of a reductive nature can sufficient reproductive power for true breeding be contrived. The exhaustion implied by its indirect methods of spore-production injuriously impairs survival-capacity.

The case of the moss shows reproductive nemesis resulting from a parasitic diathesis, a mitigation of which is necessary to ensure a more normal development of sex.

CHAPTER VII

GROWTH AND DEATH

"Nothing seems to have been more variable than the rapidity of the comparative evolution of the different phyletic branches."

"In a pretty general way it may be said that *the rapidity of evolution of a group is in inverse ratio to its longevity.*"

"The species and genera of the present time represent those which have not yet arrived at the senile phases; but it can be foretold that some of them, the elephants, the whales, the ostriches, etc., are approaching this final phase of their existence."

"The struggle for life is decidedly insufficient to explain the reason of the extinction of species."

"But if the mere fact of these extinctions is easily proved, on the other hand, the precise cause of it has long remained obscure, and even at the present day is far from being fully apparent."—CHARLES DEPÉRET, in *The Transformations of the Animal World.*

§ 1. Limit of Growth—Constancy of Average Size and Rationale of Teratological Developments.
§ 2. Utility of Death.
§ 3. Spencer's Analysis of Limit of Growth.
§ 4. Mechanism of Cell-division—an Indictment of Antithesis.
§ 5. Antithesis of Growth and Multiplication.
§ 6. Parasitism determines Degeneracy of Sexual Reproduction.
§ 7. Distinction between Sacrifice and Reproductive Nemesis.

§ 1. *Limit of Growth—Constancy of Average Size and Rationale of Teratological Developments.*

WE learn from the *Evolution of Sex* that, "as certain as the fact of growth, is the definiteness of its limit alike for cell and for organism."

"The unit masses generally remain very small. They have their maximum size, approximately constant for each species. Up to this point they grow, but no further. The same, as everyone knows, is true of multicellular animals. The size fluctuates slightly according to the conditions of individual life, *but the average is strikingly constant.*"

In this connection, I would observe, it is important to remember that this constancy of proportion is frequently distorted by a constancy of dysteological habits, and that transmission of pathological states is a constant concomitant of the evolutionary process. Individuals exceed their normal limits of growth by nutritional excesses. The arthritic tendency arising from habitual surfeit or infeeding is hereditarily transmitted. The cumulative effects of dysteleological nutrition, as they are alone responsible for sexual dimorphism, are likewise and *pari ratione* responsible for so-called teratological developments—abnormality and monstrosity. Rise of type, as in the past it must have justified a definite increase of dimensions, also frequently led to an abuse of position and to physiological and morphological exaggerations, involving teratological (pathological) developments. Monstrous types of organisms can thus all be traced back to smaller forms exhibiting normal habits and functions. The growth to a relatively large size, as observed in the giant Pterodactyles of the Cretaceous period, the colossal Dinosaurus of the Upper Jurassic and Cretaceous, and the large mammals of the Pleistocene and of the present day, is considered a mark of old age in the species. The races so distinguished ran their course quicker than others. It was duly pointed out by A. S. Woodward, at the British Association meeting at Winnipeg, that "it is not, of course, all the members of a race that increase in size; some remain small until the end, and they generally survive long after the others are extinct." It is thus again necessary to emphasise the pathology and precariousness of all accelerated antithetic and teratological developments, and to trace them back to their universal cause, which involves predatory habits. Premature old age in a race, attended by what is inadequately termed a "too advanced specialisation," is thus a mark of pathological deterioration. The inferiority produced requires no "selective" explanation. That my interpretation is fairly correct, may again be gleaned from the following passage from Charles Depéret's *The Transformations of the Animal World*:—

"It is this inferiority, arising from a too-advanced specialisation, which enables us to understand the extinction of forms, the most powerful of any from their size and from their perfected natural weapons. Accustomed to live in *luxurious indolence*, these immense beasts could neither bear the diminution of their food nor the other changes of the environment. It is a well-established fact that none of the large types of terrestrial animals has been able to maintain for long its supremacy in the course of the geological ages. All the groups of the Carnivora, of the

Ungulates, and of the Quadrumana known in detail, commence with types small in size and of puny strength—a fruitful law of which the exact formula seems indeed to be due to Cope, and which serves as a real clue to the researches of modern palæontology."

As regards the palæontological law of Cope's here alluded to, I would like to emphasise again, however, that for the most part it must be understood as covering a course of pathological developments. To regard abnormality and monstrosity as something accidental—neither physiological nor pathological—classifying them as teratological or as "over-specialisation," though convenient, is to shirk the explanation, and is therefore highly unsatisfactory. It is one of the shortcomings of present-day biology, due to the lack of a proper analysis, with the attendant fixed standards.

§ 2. *Utility of Death*

What with a wide prevalence of pathological states involving constant danger of their increasing transmission, and extreme and expensive forms of reproductive sacrifice on every hand, the utility of death as a preventer of evil should be obvious to every student. The mission of death may be said to be the elimination of parts and organisms which show manifest dysteleological habits of life and growth. The best interests of a species frequently require the death of individuals. The use of death as checking undesirable growth is thus almost comparable to that of fertilisation, which in Hatschek's opinion has the function "*of checking variation and holding the species true to the specific type.*"

Hatschek and Weismann, beholding reproductive vicissitudes on every hand, indeed frequently express views similar to the interpretation of development put forward in this work. Hatschek we even find reported as stating that "all nutrition is reproduction." It is necessary, however, to be more concise regarding the analogy between death and fertilisation. Fertilisation has a direct use as a means of enhancing racial status, but it can be said to act as a check upon undesirable developments only in so far as the habits of the respective species do not impede its functionings. Weismann has made some very important pronouncements regarding the institution of death. He holds that "death itself, and the longer or shorter duration of life, both depend entirely on adaptation. Death is *not* an essential attribute of living matter; it is neither necessarily associated with reproduction, nor a necessary consequence of it."

However this may be, we have seen that parasitic "adaptation" is the main cause of a curtailment of life, and that it can never be really natural. This is not, however, what Professor Weismann wishes to imply by the above utterances, as far as I can gauge his position. I apprehend, on the contrary, that his views are biassed by his prepossessions regarding Protozoan immortality.

§ 3. *Spencer's Analysis of Limit of Growth*

Professors Geddes and Thomson say on this subject: "Spencer has analysed the limit of growth, in terms of the continual tendency that increase of mass must have to outrun increase of surface."

Thus again we are brought face to face with a "constant tendency of increase." As in the case of Malthus, again we find that the real checks—the teleological checks—are overlooked, and imaginary happenings—contents outrunning their surface—are introduced instead.

"In spherical and all other regular units the mass increases as the cube of the diameter, the surface only as the square. Thus the cell, as it grows, must get into physiological difficulties, for the nutritive necessities of the increasing mass are ever less adequately supplied by the less rapidly increasing absorbent surface. The early excess of repair over waste secures the growth of the cell. Then a nemesis of growing wealth begins. The increase of surface is necessarily disproportionate to that of contents, and so there is less opportunity for nutrition, respiration, and excretion. Waste thus gains upon, overtakes, balances, and threatens to exceed repair. Suppose a cell to have become as big as it can well be, a number of alternatives are possible. Growth may cease, and a balance be struck; or the form of the unit may be altered, and surface gained by flattening out, or very frequently by outflowing, processes. On the other hand, waste may continue on the increase, and bring about dissolution or death; while, closely akin to this, there is the most frequent alternative, that the cell divide, halve its mass, gain new surface, and restore the balance. Here, in fact, the famous law of Malthus holds good."

Herbert Spencer here very lucidly though unwittingly, states the case of pathology and parasitism and consequent limitations. The warnings contained in the above passage against surfeit and undue increase of mass are so emphatic that he should have been the last man to uphold the false and contradictory idea of a "normal plethora." But he had no measure of normal developments, and hence he fell into the same pitfall that engulfed so many of his contemporaries. As regards his theory of cell-division at the limit of growth, Professor M. Hartog rightly points out in the *Contemporary Review*, April 1908: "His accounts of the proximate causes of the actual division are inadequate or absent. In many cases, it is true, a cell usually divides across the longest diameter, a method which has a modicum of physical justification; but in the cambium (formative layer) of trees the division is parallel to the length, and rather in accordance with the future needs of the plant than with what we know of the existing physical conditions. To use Foster's words, the cell divides 'as it wants to,' or, rather, as the tree wants it to."

§ 4. *Mechanism of Cell-division—an Indictment of Antithesis*

When it comes to the mechanism of cell-division itself, the facts of definiteness of arrangements again strikingly stand out.

"The orderliness and complexity of these changes forbid any offhand attempt to analyse the real physiological movement by which the growth of all multicellular organisms is effected."

And now, in Geddes and Thomson's own conclusions, we come across a kind of indictment of antithetic development and of mere "bigness." "Organisms in their entirety have very definite limits of growth. Increase beyond that takes place at a risk, hence giant variations are peculiarly unstable and short-lived. Or, again, just as the single cell has found, *probably somewhat pathologically*, a surface-gaining expedient in the emission of mobile processes, so many organs, notably leaves, have struck a balance between mass and surface by becoming split up into lobes and more or less discontinuous expansions."

As I have urged throughout, such pathological expedients are not confined to a few individual cases here and there, but they are represented by phenomena extending in various manifestations over a wide range of inorganic as well as organic evolution.

§ 5. *Antithesis of Growth and Multiplication*

We need not pause long to consider further the theory on "The Antithesis between Growth and Multiplication, between Nutrition and Reproduction," as represented in the *Evolution of Sex*. It is of the now familiar rhythmic-metabolic kind. "The life of organisms is conspicuously rhythmic." . . .

"Foliage and fruiting, periods of nutrition and crises of reproduction, hunger and love, must be interpreted as life-tides, which will be seen to be but special expressions of the fundamental organic rhythm between sleep and waking, rest and work, upbuilding and expenditure, which are expressed on the protoplasmic plane as anabolism and katabolism."

Here follow the usual corollaries from the interpretation of so-called "favourable conditions" which has been sufficiently criticised above.

The famous experiments of Maupas, reference to which has already been made, on the common infusorian (*Leucophrys patula*), are instanced as proof positive of these metabolic explanations.

"In regard to a common infusorian (*Leucophrys patula*), Maupas observes that with abundant food the ordinary fission continues, but with scanty nutrition a metamorphosis occurs, followed by six successive divisions, which have for their end conjugation. That is to say, we have positive proof that in these lowest organisms, katabolic conditions determine the beginning of sexual reproduction, a matter of no small importance to the evolutionist. Generalising, M. Maupas concludes that the reproductive power of ciliated infusorians depends, (1) on the quality and quantity of the food; (2) on the temperature; (3) on the alimentary adaptation of the buccal organs. He also demonstrates that with a *vegetarian diet their rate of asexual reproduction is much less*, and the size smaller. Taking these facts, along with his important demonstration that the life of ciliated infusorians runs in cycles of asexual reproduction, necessarily interrupted (if the life of the species is to continue) by conjugation or sexual reproduction, we again reach the general conclusion that anabolic conditions favour asexual reproduction, rather than sexual; and that while preponderant anabolism is the necessary condition of the overgrowth which makes the asexual reproduction possible, the onset of the katabolic preponderance is necessary to the act itself."

Scarcity of food can hardly be said to constitute a "katabolic condition," although it must make for moderation. If the reduction of the nutritive overflow eventually permits, a return to sexual unions is possible. Maupas's experiments unmistakably show that overnutrition and infeeding interfere with sexual reproduction, that not only quantity but also quality is of paramount importance, that legitimate nutrition quickly restores normality of sex, and that there are other factors more or less equivalent in value to food.

As regards these cultures of Maupas, we read in Newton Smyth's "Place of Death in Evolution"

(*Arch. de Zool.*, 2nd series, vi. pp. 211, 261): "Maupas noticed also that the degenerate forms in his cultures were enabled to continue and multiply only by great care. In a free state individual cells, which might become degenerate, would succumb soon after their appearance."

"His investigations bring out further the interesting fact that one of the first and most important degradations of senescence consists in *atrophy*, at first partial, then more complete, of the *sexual organs.*"

"Maupas further observes that the individuals afflicted with this first degree of degeneration can still continue to live and multiply; but such life has *something abnormal* about it, until it becomes completely useless. 'They and all their descendants, in short, are doomed to an inevitable death. They live still an individual life; but they are dead to the life of the species' (*ibid.*, pp. 261–2). Thus death strikes first at forms which have become useless to the species. When nature's method of keeping up the germ-plasm of the nucleus is interfered with, senescence and death result."

§ 6. *Parasitism determines Degeneracy of Sexual Reproduction*

The indiscriminate mixing up of illegitimate with genuinely metabolic conditions again comes out very strikingly in the following passage:—

"It is again, on the present view, readily intelligible why in the exceptionally favourable anabolic environment of bacteria and many parasitic fungi sexual reproduction should be absent. Marshall Ward has pointed out, *that the more intimate the degree of parasitism or saprophytism*, the *more degenerate the sexual reproduction.* The greater the anabolism, in other words, the more growth and the less sexuality. That such comparatively complex organisms can continue their asexual reproduction, dispensing altogether with the acknowledged stimulus of fertilisation, may probably be at least partially explained on the assumption that the abundant waste-products of the host act as *extrinsic stimuli.*"

Again we get the misconception of an "anabolic environment." Apart from this sophism, however, Marshall Ward's statement of facts is of the utmost importance. It corroborates my contentions respecting the dysteleological significance of parasitism, and it shows how they are supported throughout by *veræ causæ.*

To support their contention that reproduction begins with rupture — "a katabolic crisis" — Geddes and Thomson remark that "large cells beginning to die, save their lives by sacrifice. Reproduction is literally a life-saving against the approach of death."

"An organism which is becoming exhausted, saves itself, and multiplies in reproducing."

§ 7. *Distinction between Sacrifice and Reproductive Nemesis*

Reproduction is here practically identified with disease and death, which is undoubtedly carrying the analogy too far. It is evident that it is only in exaggerated cases where the association is as close as here expressed. The idea of sacrifice in reality has many gradations. We must distinguish between sacrifice entailed in the cause of genuine progressive evolution and that suffered by way of meeting retribution (disease, pædogenesis, curtailment of every kind).

Direct sacrifice as a method instituted for the advancement of a species, for the establishment of higher possibilities, is general throughout nature and seen in numerous normal phases of life. Thus some writers speak of "the sacrificial property" acquired by "self-effacing" cells; others have rightly laid great stress on the enormous sacrifices frequently entailed in "animal devotion."

The greater part of reproductive sacrifice actually borne, however, I assert, is due to pathological causes and to nemesis.

The universal occurrence of such sacrifice, however, must not blind us as to its abnormal character.

It is thus rather as a retribution than as a direct means of furthering the race that "the organism not unfrequently dies in continuing the life of the species," that "in some species of the primitive annelid *Polygordius*, the mature females die in liberating the ova," and that in so many instances "from first to last reproduction is linked to death."

It is only fair to state, however, that at this stage Geddes and Thomson make certain qualifications as regards the sufficiency of their metabolic "see-saw."

"It is an incomplete conception, however, unless it be remembered that about this 'organic see-saw' there blows the wind of the environment, swaying it now to one side, now to the other."

This "wind of environment," however, is of their own creation, as was already pointed out. Nature is not so capricious as a verbally entangled theory would fain make it appear.

> "Son più stupende di natura l' opre
> Che 'l finger vostro, è più dolci a cantarsi."

SUMMARY

What has been said about constancy of average size must not deceive us about the facts of pathological transmission—nutritive excesses finally resulting in overgrowth. Monstrous types can all be traced back to smaller ones. The small generally survive long after the monstrous are extinct. The palæontological law of Cope that all the groups of the Carnivora, of the Ungulates, and of the Quadrumana known in detail commence with types small in size and of puny strength, which is said to serve as a real clue to the researches of modern palæontology, must be read with the addendum that for the most part it covers a course of pathological developments. To classify monstrosity and abnormality under the heads of teratology and "over-specialisation" does not provide an explanation of the respective phenomena.

Death is useful as a safeguard against perpetuation of degeneracy. Its mission is the elimination of parts and organisms growing dysteleologically—the checking of undesirable growth; whilst fertilisation is directly useful by enhancing racial status, it is a means of checking undesirable developments only in so far as the respective racial habits have not become too abnormal. The analogy between death and fertilisation therefore requires qualification.

Rightly interpreted, the factors of cell-division are an indictment of antithesis. Maupas's experiments demonstrate that an antithesis between growth and multiplication may be reduced by the introduction of legitimate nutrition.

Though the greater part of reproductive sacrifice in evolution actually borne be due to retribution, it by no means follows that normally there is as close an identity between reproduction and death as some writers are seeking to establish.

CHAPTER VIII

SPECIAL PHYSIOLOGY OF SEX AND REPRODUCTION

> "Any group of animals to which we can turn may possibly be the result of degeneration, and yet offer no evidence of that degeneration in its growth from the egg. Accordingly, wherever we can note that a group of organisms is characterised by habits likely to lead to degeneration, such as I have enumerated, viz. parasitism or immobility, or certain modes of nutrition, or again, by minute size of its representatives—there we are justified in applying the hypothesis of degeneration, even in the absence of any confirmatory evidence from embryology."—Sir E. RAY LANKESTER.

§ 1. Determining Factors in Sexual Development.
§ 2. Weismann's Germ-Plasm Theory.
§ 3. Precocious Reproductive Maturity.
§ 4. Faulty Adaptations.
§ 5. Embryonic Cannibalism under Retributive Selection.
§ 6. Higher Organisms characterised by Effective Arrangements.
§ 7. Persistence of Illegitimacies.
§ 8. Parental Sacrifice and "Rhythmical Anabolic" Necessities.
§ 9. Normal *v.* Exaggerated Costliness of Birth.
§ 10. Association of Death and Reproduction.
§ 11. Terrible Forms of Reproductive Nemesis.
§ 12. "Organic Immortality."
§ 13. Ultra-Mortality (Gregarinæ, Amœba, Foraminifera, Radiolaria, Calcareous Formations, Phosphorescence, Fossils, and Chalk Rocks).
§ 14. Doubtful Origin of Infusoria.
§ 15. Protozoan Stage and the Cemetery of Cells.
§ 16. Inadequacy of Weismann's Contentions.
§ 17. Qualifications Necessary.
§ 18. Alleged Immortality Fictitious.
§ 19. The Wheel of Life.
§ 20. Death the Arrester of Evil.
§ 21. *Modus Operandi* of "Organic Immortality."

§ 1. *Determining Factors in Sexual Development*

The former conception of the existence of "a continuous necklace-like chain of sex cells from generation to generation—a continuous chain upon which the mortal individual organisms arise and drop away, like so many separate and successive pendents"—according to Weismann, "gives a false simplicity to the facts. A chain of insulated sex-cells, connecting the parental fertilised ovum with the germ-cells which develop into offspring, is, so far as we yet know, only rarely demonstrable. In other words, the rudiments of the reproductive organs often appear at a relatively late stage in the development."

Such being the case, Weismann found it necessary to construct his now famous germ-plasma theory. "Those cells in which the original germ-plasma most predominates become the reproductive cells."

The doctrine of the continuity of germ-plasma, however, "is strictly an hypothesis."

This hypothetical substance itself is conceived of not only as possessed to a marked degree of inclination towards orderliness and definiteness, but also as capable of inducing changes in the currents of the "somatic" cell-world.

Thus we read in the *Evolution of Sex* that: "The maturation of the sexes not only acquires increasing definiteness in the higher forms, but becomes associated with various characteristic accompaniments. The profound reaction of reproductive maturity upon the whole system is best marked in birds and mammals, and perhaps most in man."

Sexual development is thus correlated with every other development which shows to greatest advantage at the higher stages of life. Date of appearance of sex is physiologically indicated, according to whether an enhancement or a curtailment of life has been merited by a species. Whether a particular cell is to specialise as a "somatic" or sexual cell is teleologically determined. Every predominance of retrograde influences, as it stimulates in the direction of morbid and precocious reproductive activity, determines as sexual a number of cells which might otherwise have functioned as somatic cells, and may thus be the cause of cerebral atrophy for instance. Just as individuals in a human polity may under varying conditions of life have new duties assigned to them, so individual cells may according to change of circumstances in the total system undergo corresponding changes in their functions regeneratively or reproductively.

We are told in the same valuable work: "There is no doubt that the advent of sexual maturity varies with environmental conditions of climate, food, and the like. Broadly speaking, sexuality becomes pronounced as growth ceases."

The first statement is of considerable importance. But we have seen how necessary it is to be definite on the point of "environmental" conditions—by no means determined by external causes alone—and to guard against conclusions from exaggerated instances.

The almost immediate reference to flukes and cestode parasites following the above passage again shows that abnormalities are unduly dominant in the minds of our "savants."

The further statement that: "It is only as the differentiation increases, as the contrast between body-cells and sex-cells becomes emphasised, as the asexual mode of getting rid of surplus wanes, that the typical liberation of sex-elements which marks sexual maturity becomes a striking fact in the life," is only saying in so many words that the ratio between nutrition and sex is capable of improvement, and does improve as we ascend the series.

Here, as with many other writers, it is only in the most extreme cases that reference is made to pathology; the line between physiological and pathological developments being conveniently and quite arbitrarily drawn, as it suits the fancy or the theory of the particular writer. So long as new terms can be coined new classifications are cheerfully made wherever explanations fail, and thus the increase of our "nature-knowledge" proceeds apace.

In the higher organisms, it is true, we are at least vaguely referred in the often-quoted work (*Evolution of Sex*) to the test of "the fittest offspring"; thence, however, with one bound our attention is again transferred to the parasitic region, where "sexual maturity" is more rapidly attained.

It is needless to repeat that the introduction of such startling transitions cannot be considered a satisfactory method, that such widely differing stages cannot be indiscriminately compared. "Sexual maturity" *per se* is by no means a symptom of desirable development.

§ 2. *Weismann's "Germ-Plasm Theory"*

The following passage from Professor Weismann's *Germ Plasm* illustrates not only the hypothetical character of his theories, but also the fatal tendency to use abnormal happenings as a basis for far-reaching generalisations:—

"We are still far from being able to describe in detail the entire histological process of the differentiation of a cell. The passage of invisible 'biophors' through the pores of the nuclear membrane is probably just as admissible an assumption as that of the independent power of motion thereby necessitated in these bearers of vitality; but the histological structure of a cell is not completed by the mere emission into the cell-body of a few kinds of biophors with great powers of multiplication. Numerous questions suggest themselves in this connection, all pointing to the fact that forces are at work of which we are at present ignorant. The immigrating biophors are the mere material which forms the histological structure of a cell, only when subjected to the guiding forces—presumably those of attraction and repulsion—which must be located in the biophor. We can as yet form no more exact conception of this process than we can of the manner in which the biophors already contained in the cell-body behave in respect to those which have migrated into it from the nucleus. Presumably a struggle of the parts occurs, in which the weaker are suppressed and serve as nutritive material for the stronger ones."

It is evident that the view explained so far of teleological adjustment, concerning developments in general, is calculated to provide more rational concepts than the narrower "selective" view.

§ 3. *Precocious Reproductive Maturity*

But to return to the *Evolution of Sex*. The term "precocious reproductive maturity" conveniently covers a few inconveniently blank chapters of pathology, although the very accentuated *misère physiologique* here involved makes at least a slight reference to the subject of pathology imperative. We are told :—

"In contrast to such cases, precocious reproductive maturity occasionally occurs. We have already referred to those dipterous midges (*Cecidomyiæ*) in which the larvæ for successive generations become reproductive, though only parthenogenetically. Very striking, too, is the trematode worm *Gyrodactylus*, which recalls the mystical views of the preformationists, in exhibiting three generations of embryos, one within the other, while the oldest is yet unborn. The well-known Axolotl of Mexican lakes, though with its persistent gills in a sense the larval form of *Amblystoma*, attains of course to sexual maturity. A more marked precocity has been observed in the alpine salamander (*Triton alpestris*). In higher organisms, it occasionally happens that long before growth has ceased or adolescence been reached sexuality sets in, especially in the male sex, but this is fortunately a *comparatively rare pathological occurrence*."

Consideration of the life-history of *Gyrodactylus*, however, shows that reproduction and death need not normally be so intimately related as represented by Geddes and Thomson. For this worm, in so far as it is a veritable sower of death, and an emblem of pronounced dissociation, is also strikingly characterised by a highly parasitic mode of life. The Trematoda in general represent an extensive order of parasitic worms, found in the internal cavities of animals. "Some are injurious parasites of domestic animals." The Gyrodactyles live in the gills of fishes, and are armed with very variable hooks, which serve to anchor them; and "sometimes a digestive canal and organs of sensation are found in them."

§ 4. *Faulty Adaptations*

A moderate, though again quite vague, amount of pathological development is conceded by the authors in the case of menstruation. They say :—

"Though thus clearly a normal physiological process, it yet evidently lies on the borders of pathological change, as is evidenced not only by the pain which so frequently accompanies it, and the local and constitutional disorders which so frequently arise in this connection, but by the general systemic disturbance and local histological changes of which the discharge is merely the outward expression and result."

But may it not be that in menstruation also we must behold an instance of faulty adaptation?

With a greater complexity of organisation, man should have evolved a commensurate stability of equilibrium and control of function sufficient to prevent such highly pathological developments.

This is indeed hinted by Geddes and Thomson :—

"It must be allowed that the primary importance of the timely encounter of the ovum and spermatozoon has perpetuated in the various groups a varied series of adaptations securing fecundation. At the same time, the increasing differentiation of the sexes has in the higher animals been enhanced by psychical as well as physical attractions, thus more and more ensuring the continuance of the species."

Right use of a great variety of powerful factors of adaptation might thus well have ensured a greater freedom from suffering, had it not been that physiological transgressions have been persisted in right up into the very highest spheres, interfering with natural beneficence, *i.e.* harmonious adaptations. It has been said that "*l'homme ne meurt pas, il se tue.*"

The facts of human transgression are not incorrectly reported by Newman Smyth in *The Place of Death in Evolution*, pp. 156–7 :—

"It is true, on the other hand, that the extreme specialisation of living matter in the body and the brain of man, and the unstable complexity of his organisation, capable as it is of adapting itself to the widest range of external conditions, render man liable to new and ever-changing attacks from the outer world upon his physical integrity; that the very perfectness of his being exposes him to peril of worse suffering and more awful death. But we cannot affirm that this greater exposure of his organisation might not have been compensated by his keener intelligence and his recuperative spiritual energy, if sin had not thrown its natural consequences as a heavy counterweight into the scale, and brought the glory of his life down into a deeper condemnation. The facts are known and obvious, that disease and death have assumed in man's life forms of suffering, terror, and loathsomeness unknown in the animal creation, which has neither risen like man to moral freedom, nor experienced the retro-active consequences of a life false to nature and unworthy of itself."

§ 5. *Embryonic Cannibalism*

When we now turn to what is termed "early nutrition," we are again presented with striking pictures of parasitic retribution.

Especially marked is this in the case of the whelk and some related forms, in which (*Evolution of Sex*) "a curious cannibalism is well known to occur among the crowd of embryos enclosed within a common capsule. The stronger and older devour the younger and weaker—a struggle for existence happily of exceptional precociousness."

It is only necessary now to interpose by way of explanation that the whelks are *typically carnivorous* molluscs—"they are largely used for food (*sic*) and bait, and are caught in creels baited with garbage" (*sic*).

§ 6. *Higher Organisms characterised by Effective Arrangements*

By way of contrast, with the higher organisms, the rectitude of life, which constitutes them what they are, expresses itself in the institution of organs and functions of a beneficent and effective character. Sacrifice is associated with "sweet reasonableness" and with length of days in the hands of Wisdom.

"In the higher vertebrates (above amphibians), fœtal membranes — amnion and allantois — are developed, in addition to the yolk-sac which encloses the yolk. Of these, the amnion is mainly protective, and the allantois at first almost wholly respiratory. But in birds (and probably to a slight extent in reptiles) the allantois begins to assume nutritive functions, assisting in the absorption of the yolk. In placental mammals, however, a nutritive function becomes paramount, the allantois forming the greater part of the embryonic side of the placenta. The yolk-sac is here virtually yolk-less, but in the lower orders may absorb nutriment as it did in birds, though from a different source—the maternal wall. In most cases, however, what was incipient on the part of the yolk-sac, in the exceptional elasmobranchs and lizards already mentioned, becomes the emphatic function of the allantois—namely, the establishment of a vascular or nutritive connection with the wall of the maternal uterus. By this means, though no drop of blood ever passes from mother to offspring, a very intimate osmotic transfusion is effected."

Osmosis, which is practically non-acceleration of growth, takes the place of indiscriminate unions and precocious developments. Fœtal membranes take the place of yolk-glands.

§ 7. *Persistence of Illegitimacies*

The beauty of the placental mammalian arrangement unfortunately is often soiled by the persistence of various degrees of illegitimacy.

"That peculiar liability of these uterine and mammary tissues to disease, which furnishes the most tragic possibilities of the life of woman, becomes thus less mysterious. We can understand more readily the association of such diseases with much of what we are pleased to generalise as civilisation, and view more hopefully the possibilities of their enormous diminution by the rational hygiene of civilisation properly so-called."

Whilst in perfect agreement with the sentiment here expressed, I apprehend that Geddes and Thomson have not established the character of the "anabolic overflow" clearly enough to enable us to begin at once and with clear vision the salutary work of reform and prevention.

§ 8. *Parental Sacrifice and "Rhythmical Anabolic" Necessities*

In this connection again, "the metabolic bias" explanation of sex seems to be vague and inadequate.

"The physiological sacrifice of the female bird does not end with providing the large capital of nutritive material with which the germ is endowed, but is continued in all the patience of brooding. In passerine birds the male relieves the female in her task of love, and in the ostrich tribe takes the duty usually upon himself."

We have seen, however, that the possibility of parental care after reproduction is frequently precluded owing to pathological exaggerations. It is the physiological habit which largely determines "metabolic bias" and "increase of circulation" on the one hand, and possibilities of genuine parental affection and of social life on the other.

When we find Geddes and Thomson constrained to concede that, "in any case, the patience and solicitude of the brooding, and the subsequent diligence in feeding the hatched young, are obviously the expression of genuine parental affection," they are almost throwing their metabolic theory overboard. Their theory, verbally externalising what it fails to explain in terms of response, breaks down in the face of a new and mysterious psychological factor. And yet there is an intimate connection between the rise of this factor and metabolic developments, as I have endeavoured to demonstrate throughout, and as will again be seen in the next chapter.

§ 9. *Normal* v. *Exaggerated Costliness of Birth*

It has already been pointed out that there is a great difference between progressive reproductive sacrifice and reproductive nemesis. The former by no means needs to take the shape of the latter.

The transitional stages of progressive differentiation —requiring effort, vigilance, and sacrifice—are of an altogether different nature from those representing retribution under retrogression, connoted by nemesis and suffering under belated and frantic attempts to stem the tide of generic ruin. The distinction thus drawn is all-important. The doctrine, or rather the prejudice, has unfortunately crept into the general literature on the subject, that an exaggerated costliness of birth is the natural order in the early stages of evolution—or in other words that the early self-sacrificing methods of reproduction, which "*nature later changes* into the better way of keeping the mother among the living for the sake of the child, are natural."[1] Is it not true that "*pulchrorum autumnus pulcher*"?

---

[1] *The Place of Death in Evolution*, by Newman Smyth.

Whilst warning us against ideas of posterior utilities and after-thoughts of our invention, our scientific men not at all uncommonly make nature "change her rule," when such a presumption is required to bolster up their pet theories. But is it not more probable that nature's law is eternal, and that this postulated better behaviour on her part at a late juncture is but an imputation marking human ignorance and limitation? Is it that nature has changed or that the organism has changed, has responded to her call for harmonious adaptation and progress, or, in the alternative, has lapsed into dysteleological modes, involving clashes and retributions?

Nature's law is unmistakable; the degree of legitimacy in a species determines its status, its chances of progress, and its freedom from nemesis.

Given legitimate conditions, and sacrifice will turn into delight—the very reverse of the reproductive nemesis under parasitism.

The following interpretation of sacrifice, given by Newman Smyth (by no means an exceptional or uncommon version), brings out its value as a means to greater differentiation, greater delights, and higher ends generally. Although failing to provide any explanation, this view yet voices the conception of teleological, *i.e.* harmonious, adaptation as an antidote to nemesis.

"Alike in our religious conception of it, and in the use of it in nature, sacrifice is to be regarded as a means of life, which would forfeit its moral value, and lose all its beauty, if it should be chosen as an end of life. In evolution sacrifice appears to be a method followed by nature for the advantage of a species, or for the introduction of a higher order of organic development. Each evolutionary order is sacrificed, not as though nature took pleasure in sacrifices or in the blood of bulls and goats, but for the benefit of the order above it, as though at any cost nature must press on to the goal, and win the crown of life. Thus the inorganic is broken up in order that from its dust the plant may spring and blossom; the plant in turn gives up its fruit that the animal may be nourished; and the law of prey among animals is not to be regarded as a reckless thirst in nature for blood, but it indicates rather the existence of a scale of adaptations for offence and defence, and of a system of sacrifice and reprisal, by means of which on the whole vital organisation is specialised, refined, rendered more agile and responsive, and eventually made meet for the kingdom of mind, to which man comes in the power of the spirit."

§ 10. *Association of Death and Reproduction*

In the *Evolution of Sex* we are further told that: "The association of death and reproduction is indeed patent enough, but the connection is in popular language usually misstated. Organisms, one hears, have to die; they must therefore reproduce, else the species would come to an end. But such emphasis on posterior utilities is almost always only an afterthought of our invention. The true statement, as far as history furnishes an answer, is not that animals reproduce because they have to die, but that they die because they have to reproduce. As Goette says, "it is not death that makes reproduction necessary, but reproduction has death as its inevitable consequence." This of course refers primarily to the incipient forms of both these katabolic processes.

"It is necessary to give a few illustrations. Goette refers to Haeckel's *Magosphæra*, a protozoon which, just as it had formed for itself a multicellular body, broke up into the component units. These lived on, and there was no corpse, but at the same time the multicellular colony was no more. Again he takes the case of the lowly and somewhat enigmatical Orthonectids, which Van Beneden has classed as Mesozoa between the single-celled and the stable many-celled animals. Here the mature female forms numerous germ-cells, and terminates her individual life by bursting. The germs are liberated, the mother animal has been sacrificed in reproduction. 'The death is an altogether inevitable consequence of the reproduction.'

"Nor is this sacrifice confined to the incipient multicellular organisms. Thus, in some species of the annelid *Polygordius*, the mature females break up and die in liberating their ova. This is approached, but suggestively avoided, in a genus of capitellid sea-worms (*Clitomastus*). The whole organism is not sacrificed, but only an abnormal portion of the body. This is in fact one of the keynotes to reproductive differentiation — the sacrifice is lessened, and the fatality thus warded off."

I confess that I do not see much choice between Goette's view and the popular one; especially as Goette is apparently loth to distinguish between reproductive sacrifice and reproductive nemesis. From the point of view of sacrifice organisms certainly reproduce because they have to die; from the point of view of retribution, they die because they have to reproduce, *i.e.* because their life is too imperfect and devoid of the elements of permanence to persist. The whole question, however, appears illegitimate. In the meantime it is important to recognise that both reproduction and death have a teleological significance, and that the illustrations given of burstings and catastrophes in the hour of reproduction, from among those "somewhat enigmatical Orthonectids" *et hoc genus omne*, present extreme cases of nemesis due to a dysteleological life.

§ 11. *Terrible Forms of Reproductive Nemesis*

"But again we find in some thread-worms or nematodes (*e.g. Ascaris dactyluris*) that the young live at the expense of the mother, until she is reduced to a mere husk. In fresh-water Polyzoa, Kraepelin notes that the ciliated embryo leaves the maternal body-cavity through a *prolapsus uteri* of the sacrificed mother. In the precocious reproduction of some midge larvæ (*Chironomus*, etc.) the production of young is fatal through successive generations.

"Both Weismann and Goette, though with different interpretations, note how many insects (locusts, butterflies, ephemerids, etc.) die a few hours after the production of ova. The exhaustion is fatal, and the males are also involved. In fact, as we should expect from the katabolic temperament, it is the males which are especially liable to exhaustion. The males of some spiders normally die after fertilising the female, a fact perhaps helping to throw light upon the sacrifice of others to their mates. The similarly tiny (ultra-katabolic) male rotifer—*an ideal but too unpractical lover*, without an alimentary canal—would seem usually to fail and expire prematurely, leaving the female to undisturbed parthenogenesis. Everyone is familiar with the close association of love and death in the common mayflies. Emergence into winged liberty, the love-dance and the process of fertilisation, the deposition of eggs and the death of both parents, are often the crowded events of a few hours. In higher animals, the fatality of the reproductive sacrifice has been greatly lessened, yet death may tragically persist, even in human life, as the direct nemesis of love.

"The temporarily exhausting effect of even moderate sexual indulgence is well known, as well as the increase of liability to all forms of disease while the individual energies are thus lowered."

Here it is noticeable that not a word is said as to the obvious connection of the various retributions with parasitism!

We are to be satisfied with an explanation on the lines of that mysterious hybrid quantity, the "katabolic temperament"!

The temporary exhausting effect of even moderate sexual indulgence in man; sexual disease; reproductive nemesis of the most ghastly dissociative order, all are regarded as being on one plane!

The tiny (ultra-"katabolic") male rotifer is held out as an ideal though "too unpractical" lover!

The absence of an alimentary canal in this most pernicious stage of degeneracy and degradation would seem to appeal pre-eminently to our present-day scientific imagination.

Next to the absence of a few such cumbersome organs as the alimentary canal, however, it is the absence of burial which has fired the imagination of our biologists. They have now abolished those old-fashioned, vague notions of heaven and an after-life, and presented us instead with the ideal of the Protozoan heaven and Protozoan immortality.

§ 12. "*Organic Immortality*"

Nothing probably in the whole history of science is so manifestly open to justifiable ridicule as the current stories of "organic immortality."

"Comparatively little is yet known about the length of life among lower animals, but there is no reason to doubt that all multicellular organisms die. We have just emphasised the view of Goette and other naturalists, that reproduction is the beginning of death; which is not inconsistent with the apparent paradox, that local death was the beginning of reproduction. Allowing, then, that multicellular organisms at any rate are mortal, and that the very blossoming of the life in reproduction is fated with a prophecy of death which is its own fulfilment, we have to face two questions: What of death in the Protozoa? and, In what sense is there an immortality throughout the organic series?

Often enough already, in the preceding pages, we have had to reiterate the contrasts between the Protozoa and the higher animals. These firstlings are physiologically complete in themselves, and have at least very great, if not unlimited, powers of self-recuperation. They leave off where higher animal life begins, that is to say, in a unicellular state. They do not form bodies. Their reproduction, moreover, is in the majority simple cell-division into two. *If there be loss of individuality*, there is hardly loss of life. *Death is not so serious when there is nothing left to bury.* Nor in most cases can one half of the divided unit be the mother individual, and the other the daughter, for the two appear indistinguishably the same. Thus an idea, broached long ago by Ehrenberg, has been revived and elaborated by several naturalists, and especially by Weismann, that the Protozoa are virtually immortal.

"In Weismann's own words, 'Natural death occurs only among multicellular organisms, the single-celled forms escape it. There is no end to their development which can be likened to death, nor is the rise of new individuals associated with the death of the old. In the division the two portions are equal, neither is the older nor the younger. Thus there arises an unending series of individuals, each as old as the species itself, each with the power of living on indefinitely, ever dividing, but never dying!"

Here, it is evident that we are dealing with verbal and hypothetical entanglements.

First, death may be nothing but loss of individuality; if this be so, the whole case lies outside the biologist's province. It would be for the psychologist to investigate the matter. Again, if death be nothing but a splitting up of components, modern biology is neither equal to the demonstration of the analysis nor the synthesis of the case. To say that "there is hardly loss of life" is as vague as it is presumptuous, especially if we remember the possibilities of dissociation. That "death is not so serious when there is nothing left to bury," I am willing to admit; but the seriousness or otherwise of the change hardly seems relevant to the argument. In the same sense, the accidental death of a flea, for instance, does not seem so serious nor so expensive an affair as the sudden demise of a prince of royal blood; nevertheless, we would not infer the lesser mortality of the insect. Inability to distinguish as to the true specific and inner nature of the results of Protozoan division should prevent us all the more from forming hasty conclusions as to their immortality.

Appearances are deceptive.

§ 13. *Ultra-Mortality*

On the hypothesis of dissociation, moreover, we must infer that many changes taking place in these "simplest" forms are imperceptible. We must likewise infer from their life-history that the intimate connection between nutrition and sex is pathologically intensified. Thus the explanation previously adduced, that the absence of a corpse is due to a startling reproductive precocity combined with a prodigious embryonic cannibalism, is readily intelligible.

Coming to the facts of their history, many Protozoa occupy a kind of neutral ground without a definite plan in either the animal or the plant world. We find among them the severest forms of retrogression and dissociation. The members of this group are said to be distinguished by the *negative* functions, by their *want of the definite characters* which other subkingdoms possess. They answer, indeed, to the following biological "ideals," which on the new analysis must stamp them with the most unmistakable signs of degeneracy: the entire absence of a nervous system and of organs of sense, and of any complete digestive system, specialised or differentiated. Further, *no symmetry or definite plan* of body-structure can be ascertained to exist; nor is there a body-cavity or internal space. Thus, if we remember that the distinction between organic and inorganic is but conventional, and that the mineral even possesses definite organisation, we can trace in the Protozoa a reversion to states similar to those of the mineral, except that the Protozoa, in cases of pronounced degeneracy, frequently cannot even compare favourably with the mineral in point of symmetry. Likewise, the immortality of the Protozoa is no more real than that of a stone.

Many Protozoa are reduced to nothing more than a mere minute speck of protoplasm.

Thus Class I., known as *Gregarinida*, are defined as *parasitic* Protozoa, destitute of a mouth. The members of the genus *Gregarina* occur as minute parasites, inhabiting the alimentary canal of certain insects (for example, cockroach) and other Annulosa, but occurring in Vertebrates also. Occasionally one extremity of the body may be provided with hooked processes, by means of which these organisms can attach themselves to the digestive tracts of their hosts. Nutrition is effected by the simple imbibition of the fluids of their hosts. There is thus no metabolic elaboration, and an utter shirking of teleological function.

In reproduction, two *Gregarinæ* may be observed to coalesce. We have the formation of cysts with ruptures or bursts. The *Gregarina* of the common earth-worm is a familiar species; that of the lobster—*similis simili gaudet*—attains a comparatively large size.

The *Amœba* is the familiar representative of Class II. Its nutrition is comparable to accretion, for food seized by means of the pseudopodial processes is engulfed within the soft sarcode body and by any portion of its surface, no distinct mouth being formed. Effete matters and indigestible products are simply ejected from the body by any part of its surface. Generation by rupture is the common occurrence.

In the *Foraminifera*, the third order of the class Rhizopoda, moreover, we get the calcareous or limy shell, marking the presence of the chemical diathesis. They are mostly marine, and are found distributed in all seas. In modern sea-beds they form a thick layer of organic deposit, which tends, as in past ages, to consolidate into a chalk-formation. The chalk or cretaceous rocks of the Mesozoic period, and particularly the white chalk, well seen in the south-east of England, is largely composed of foraminiferous remains.

The *Radiolaria*, or fourth order, possess shells, tests, or spines of siliceous or flinty matter. Class III. includes the sponges, and Class IV. the highest organisms of the Protozoa ; the Infusoria, Vorticellæ, Ciliata, and Paramœcium are all familiar names.

The Foraminifera, Radiolaria, and Spongida are represented as fossils, and the Protozoa have their own interesting palæontology.

Not a little significant it is, in this connection, that *Noctiluca miliaris*, probably an infusorian allied to the Flagellata, is the cause of the diffuse luminosity or phosphorescence of the sea.

This latter factor must not be lost sight of when it comes to a study of infusorian developments and of the cumulative effects of small causes in general; it corroborates the suspicion that these low-bred "immortals" of modern science derive their prodigious characteristics from dissociation.

§ 14. *Doubtful Origin of Infusoria*

About the modes of origin of Infusoria our biologists are still greatly at sea, for these animals present many a puzzle.

Some writers believe in their spontaneous generation. Charlton Bastian is an upholder of this doctrine, and his book, *The Nature and Origin of Living Matter*, is largely devoted to this subject. He pleads for broader views on the subject of genesis generally. Thus, referring to isomerism, he believes "that analogous transformations of living matter are constantly occurring among lower forms of animal and vegetable life, and that these are, in part, represented by multitudinous heterogenetic transformations."

But the fact of the existence of innumerable heterogenetic transformations, as we have seen, can be explained on the lines of dissociation without having recourse to archebiosis.

Nor, on the view of variations advanced in this and my previous work, need the "widespread distribution over the earth of these lowest types of life" be regarded as a proof of archebiosis.

§ 15. *Protozoan Stage and the Cemetery of Cells*

I have already hinted that the Protozoa group may include many ultimate forms of dissociated organisms which in retrograde metamorphosis have all but reached the last stage previous to extinction. The Protozoan stage, according to this view, would frequently represent the last passage to the cemetery of cells. Not unreasonably we might regard the chalk and other fossiliferous formations as for ever emblematic of an extreme consummation of dissociative tendencies.

Many an alleged instance of archebiosis and heterogenesis may probably be explained on this view; for, in preponderating dissociation, primordial modes may —magically, as it were—become resorted to. This explanation would not appear unreasonable on the theory of the retention of protoplasmic reminiscences in evolution; it would plausibly account for the dubiousness of archebiotic experiments.

The possibility of a concurrence of dissociated particles—invisible germs which Bastian would *a priori* exclude—would also have to be considered as explaining the spontaneity of many processes. The fact adduced by him, that "most simple and not-living or mineral constituents, coming into relation with one another in the presence of pre-existing protoplasm, appear, for aught we know to the contrary, to fall at once into those subtle combinations which constitute the basis of 'living matter,'" need thus not have an archebiotic significance at all, although a kind of heterogenesis may frequently enough supervene.

Bastian contends that Ciliates may be developed from Amœbæ—"after they had become encysted and had undergone segmentation—under the influence of the unnatural conditions to which they were exposed during the soaking of the lichen for many days in distilled water."

"It is certainly a fact of great significance that, of all the extremely varied kinds of Ciliata, it should be precisely these three forms found by me within the Hydatina egg-cases that were demonstrated over fifty years ago by independent observers (Pineau and J. Haime) to be convertible forms of life—to be, therefore, in a sense analogues of those crystals whose forms and colours change under varying conditions, as a result of isomeric molecular rearrangements, of a kind similar to that I have been postulating as causes of heterogenetic transformations."

In all these cases I would but see examples of reversion, of pronounced cases of degeneration *sui generis* under dissociation and incidental upon parasitism.

§ 16. *Inadequacy of Weismann's Contentions*

The facts of dissociation have entailed an expansion of our ideas regarding organic disintegration, and, conversely, in matters of integration we must now allow for a greater subtlety of components.

Weismann's words, that there is no end to the

Protozoan's development "*which can be likened to death,*" requires therefore accepting *cum grano salis*; and we cannot attach much weight to his statement that "the rise of new individuals is not associated with the death of the old."

Not only is he here trespassing into the psychological sphere, but the evidence for the probability that in the majority of cases we are dealing with an exaggerated reproductive nemesis, the process being greatly masked by phenomena of dissociation, is now overwhelming. Likewise, there is no warrant for the exorbitant claim that, after division, the two portions represent a continuous growth of individuality.

The discontinuity of growth is simply disguised by the subtlety of unions and of changes involved.

§ 17. *Qualifications Necessary*

In the *Evolution of Sex* it is further stated: "Some limitations must be noticed, which make this idea of pristine immortality yet more emphatic. It is only asserted that the Protozoa escape 'natural death'; a violent fate may of course await them like any other organisms. They have no charmed life, being as liable to be devoured as those of higher degree. In relation to the environment, however, their simplicity gives them a peculiar power of avoiding impending destiny. The habit of forming protecting cysts is very general, and thus enwrapped they can, like the ova and a few of the adults of some higher animals, endure desiccation with successful patience, which is rewarded by a rejuvenescence when the rain revisits the pools. But the doctrine of the 'immortality of the Protozoa' refers to a defiance of natural, not violent death."

"The psychological objection that the mother psyche is really extinguished when she divides into two, intrudes a conception which is hardly applicable. The individualities are doubled, nothing is really lost. Most seriously difficult are those cases where the protozoon produces a series of buds, spores, or division units, and leaves a residual core or unused remnant behind to die. But in regard to the gregarines, for instance, where such a remnant is left, it has been fairly answered that the residue is rather a kind of excretion than the parent left to perish after its reproductive sacrifice. Weismann is, however, willing to admit the possibility that in the suctorial Acinetæ, and in the parasitic gregarines, which are both somewhat removed from the normal protozoon type, there may be cases of true mortality."

§ 18. *Alleged Immortality Fictitious*

The alleged immortality now becomes more and more qualified, and finally it will be seen that it is only a kind of death, according to a special definition, which is "escaped" by the Protozoa.

Through the expedient of encystment, however, with its associated reproductive nemesis, they can endure desiccation. Evidently our "immortals" find themselves at times reduced to a very low pass.

Their "immortality" would hardly seem to be of the *noblesse oblige* character, for they disdain none of the lowest practices.

Their "immortality" requires rejuvenating—"when the rain revisits the pools." So it is with other spores, so with the mineral and the rock. The "intrusion" of psychological argument is resented as a kind of sacrilege by the devotees of "natural immortality." Having at last discovered the mystery of deathlessness, we can hardly wonder that a certain amount of infallibility must characterise the decrees of the officiating high-priests. The first working axiom of the new creed, then, is: "The individuals *are* doubled."

But our appreciativeness is most seriously taxed when we are asked to condone those very mortal propensities of the new idols—bud and spore formation, division units, and unused remnants, for instance.

Weismann reluctantly concedes a certain mortality to some of the parasitic gregarines, leaving them, however, still with the proud distinction of being of "immortal blood."

The whole case, indeed, contains reminiscences of the primitive ages. We remember the vagaries of ancient Greek deities, for instance.

Might I suggest the erection of a Protozoa-temple—built of white chalk—to commemorate the dawn of the golden age of immortality through Science?

According to Geddes and Thomson: "Another point in regard to which experts differ, is whether the Protozoa are really quite self-recuperative. They suffer injuries, they necessarily waste, portions are used up and may be ejected. The question then arises, Are those acquired defects obliterated, or do they become intensified? Is the wasting only a local death, or is it the beginning of a true senescence? This is a question which can only be answered by observation; *a priori* reasoning is here futile. The most serious criticism of Weismann's view is due to Maupas. Already we have noted his important result, that conjugation is essential to the youth of the species. Without this incipient sexual reproduction, the individuals in the course of numerous successive asexual generations grow old. The nucleus degenerates, the size diminishes, the entire energy wanes, the senility ends in death. *Maupas believes that all organisms are fated to suffer decay and death*, and protests strongly against Weismann's theory that death begins with the Metazoa." . . .

"It must be noted, however, that in natural conditions the conjugation, prohibited in Maupas's experiments, occurs when it is wanted, and the life flows on. Furthermore, conjugation has not been shown to occur in many Protozoa. It seems, therefore, more warrantable to insert Maupas's results as a saving clause to Weismann's doctrine, than to regard it as contradictory. The conclusion at present justifiable, is that Protozoa not too highly differentiated, living in natural conditions, where conjugation is possible, have a freedom from natural death. To this must be added the demonstrated saving clause, that in ciliated infusorians, conjugation, which here means an exchange of nuclear elements, is the necessary condition of eternal youth and immortality."

Maupas evidently takes a reasonable view, nor are his contentions based on *a priori* reasoning.

When we see that incipient modes of sexual reproduction are essential to the youth of the species, failing which successive asexual generations grow feebler and feebler, the whole imaginary fabric of immortality crumbles. To the various saving clauses now attached to the proposition of Protozoan immunity from natural death, would have to be added the further qualifications that the death spoken of is but a death according to definition—that in the respective sophistries the factors of psychology and pathology, of incipient sex and of retributive curtailment of life, are all left out of consideration.

I have alluded to the enormous amount of predisposition to disease in the Protozoa which is to be inferred from their life-history. Is it not preposterous to speak of even a shadow of "immunity"—if immunity is indeed to be the opposite of predisposition?

The verbal nature of the proposition again appears in the definition of a "body," where the Protozoa are *ex hypothesi* awarded a separate (though very suspect) position.

"Now, by a body is meant a complex colony of cells, in which there is more or less division of labour, where the component units are no longer, like the Protozoa, in possession of all their faculties, but through division of labour have only restricted functions and limited powers of self-recuperation."

§ 19. *The Wheel of Life*

A different line of argumentation — a supposed corollary from the above sophism, yet in reality an adumbration of a profounder philosophic thought quite independent of the sophism—is introduced when we are told that (*Evolution of Sex*) :—

"If death do not naturally occur in the Protozoa, it is evident that it cannot be an inherent characteristic of living matter. Yet it is universal among the multicellular animals. Death, we may thus say, is the price paid for a body, the penalty its attainment and possession sooner or later incurs."

The imaginary case of the Protozoa is thus made a kind of corner-stone towards the introduction of those sublime philosophic conceptions regarding birth and death as but a pair of opposites through which consciousness evolves as long as it suffers itself to remain attached to the wheel of life.

Needless to say the Protozoa cannot form an exception under this profounder view of evolution. They hover round the lowest rung of the ladder, so intimately and automatically entangled with this pair of opposites that they can hardly rise except momentarily above the continual alternation of birth with death. In other words, their mortality is so great as to appear almost infinite, and thus give the appearance of immortality; it is the very reverse of a salvation from the wheel of life. Death is the goal to which they approach, rather than life eternal. Their modes of life cannot leave a doubt on the matter. Death with them, moreover, wears the aspect of nemesis, rather than of sacrifice.

The contention that there is no inherent necessity of death must be rested on much safer premises than on the ultra-mortality of the Protozoa.

Not at the lowest, but at the highest rung in evolution may we discern a dawning of the prospect of discarding death. It is pre-eminently in the highest phases that a due consideration of the various factors is possible. It is there this problem must be studied.

The very idea of sacrifice and nemesis, the two determinants of death, is borrowed from the higher spheres, and can there only be seen in its true setting.

§ 20. *Death the Arrester of Evil*

And it is necessarily in the higher regions that the whole subject primarily and most relevantly concerns us.

Says Newman Smyth: "The Biblical doctrine of death as a consequence of sin runs in still another groove of the course of natural law; for there is to be observed through the life of man a retro-active working of sin upon the physical process of death. *Sin may render death naturally more evil*; its reaction may tend to make it an actual curse. The intimate connection between mind and matter involves not only effects of physical conditions upon mental states, but also reactions of the mental and moral life upon the physical well-being. These reactions of the higher upon the lower life, accumulating through the courses of heredity, become notably marked in the transmission of the physical consequences of continued disobedience of *nature's first commandment of a pure life.* By these reactions, inherited and accumulated in the flesh and the blood of the race, death may acquire a retributive character which was not at first natural to it; and thus, in *its second nature*, it *becomes the curse of sin.*"

It has already been repeatedly shown that the inherent cause of death—or rather the cause most destructive of an enhanced promise of immortality—is a dysteleological life, requiring death as an arrester of evils. This aspect is cleverly put by the following passage from *The Place of Death in Evolution* :—

"Dr Martineau, with his facile pen, has depicted at length many of the disadvantages which may be conceived to attend a too extensive prolongation of the term of human life. He has vividly portrayed the evils which might result from the overgrowth of authority, and the blight which might fall upon progress from the too protracted shadow of the continued life even of the princes of science and the benefactors of mankind, as well as the shackles which would become fixed, and the despotisms which would be rendered invincible, by the longevity for half a millennium of a Domitian, a Philip II., or a Napoleon. 'Precisely,' he remarks, 'at the juncture of two generations it is, that errors and prejudices drop out, and the dead resistance of habit to new enterprises of thought and affection falls away. . . . Death then must not too long delay his discharge of these emeriti, if the future is not to be clogged, instead of cleared, by the conquests of the past.'

"He adds also a suggestion, which falls into the line of our previous discussion, that for those who in the maturity of their powers are discharged from this life, the transition is a deliverance from the force of habits which have become fixed in the physical organism, the corporeal mechanism, to the detriment of the mind.[1] 'Death,' he concludes, 'may be but the provision for taking us abroad, ere we have stopped too long at home, and unsealing the closed inlets of wisdom, affection, and reverence, by the surprise of new light. In this aspect Death, instead of frustrating the ends of life, becomes the great arrester of ills—the liberator of souls, for both the visible and the invisible worlds.'"

The whole argument runs parallel with that here used as regards teleological adjustment.

On another page (127–128), referring to the diminution and ultimate disappearance of the useless from the order and employ of nature, Newman Smyth states:—

"We may at once raise the further presumption whether death likewise shall not be discarded, if ever there shall arise a being so constructed and so endowed that this further subjection to death would cease to be useful to the ends of life? It will also be antecedently probable that, if in the ascent of life a height and perfection is reached where sex shall be no longer advantageous, and therefore may be discarded, the distinction of sex will then vanish; and hence at that same point, through that same door opening into life's further perfection, death also with sex shall go out, never to return again."

---

[1] It must be remembered that parasitism is the main cause of mental degeneracy. It clashes with the evolution of consciousness, its attending pathology and retribution thus becoming aggravated.

§ 21. *Modus Operandi of "Organic Immortality"*

As regards the *modus operandi* of "organic immortality" through reproduction, Geddes and Thomson state that:—

"At an early stage in some cases, sooner or later always, reproductive cells are set apart. These remain simple and undifferentiated, preserving the structural and functional traditions of the original germ-cell. These cells, and the results of their division, are but little implicated in the differentiation which makes the multicellular organism what it is; they remain simple primitive cells like the Protozoa, and in a sense they too share the protozoan immortality."

As I have already shown, in these propositions the significance of precocious maturity is entirely passed over.

"The body or *soma*," Weismann says, "thus appears to a certain extent as a subsidiary appendage of the true bearers of the life—the reproductive cells."

"The bodies are but the torches which burn out, while the living flame has passed throughout the organic series unextinguished. The bodies are the leaves which fall in dying from the continuously growing branch. Thus, although death take inexorable grasp of the individual, the continuance of the life is still in a deep sense unaffected; the reproductive elements have already claimed their protozoan immortality, are already recreating a new body; so in the simplest physical, as in the highest psychic life, we may say that love is stronger than death."

Thus then it is essayed by the wildest interpretations, with the help of convenient definitions and facile paradoxes, to reach the ancient philosophic proposition of immortality and of the "the wheel of life."

Materialistic science, requiring always a tangible medium, first postulates an identity of reproductive cells and Protozoa, then proclaims the immortality of the latter, and would thus fain proceed to affirm the solution "in a deep sense" of the mystery of life.

The sudden introduction of "love" and of "the highest psychic life," and their implied identity with the "simplest physical" life, is all rather incongruous.

Nor are Geddes and Thomson unaware of this discrepancy. In the next chapter, on "Psychological and Ethical Aspects," they recur to this matter.

SUMMARY

The doctrine of the continuity of germ-plasm is strictly an hypothesis. Sexual development is correlated to general development. Date of appearance of sex is physiologically indicated.

Although generally "sexuality becomes pronounced as growth ceases," it is necessary to be careful to guard against conclusions from exaggerated cases, where the ratio between nutrition and sex has become abnormal; it is generally sought to substantiate this view by reference to the precocious "sexual maturity" of worms, midges, flukes, and cestode parasites, which is dangerous.

Faulty adaptations persist as high as the human stage. "Precocious reproductive maturation" may take the form of embryonic cannibalism where the generic habit is highly dysteleological. The whelk—a typically carnivorous mollusc —presents a striking instance.

In higher organisms, the institution of fœtal membranes connected with osmotic processes of embryonic nutrition marks the perfecting of reproductive arrangements according with juster conditions of life. The liability of uterine and mammary tissues to disease is founded on the persistence of illegitimacies.

Reproductive nemesis, though very common, must not be confounded with normal reproductive sacrifice under progressive conditions. Normal "costliness of birth" represents a price willingly paid, an expense easily borne. Exaggerated costliness or reproductive nemesis is universally associated with parasitism.

The concept of "organic immortality" is verbally contrived by modern savants. In reality, many Protozoa present a case of ultra-mortality, due to retribution, as witness their life-history and *misère*, and as borne out by diagnostic tests. Such a stage may be viewed as a last passage to the cemetery of cells reached by organic dissociation, as borne out by the history of various fossiliferous formations.

It is preposterous to rest the contention that death "is the price paid for a body" on Protozoan evidence, where death pre-eminently takes the retributive rôle as the arrester of evils.

CHAPTER IX

INSTANCE OF THE EVOLUTION OF A CRIMINAL HABIT IN ANIMALS

"And must not the doing justly produce justice, and doing unjustly produce injustice? Of necessity. But to produce health, is to establish all in the body according to nature, to govern and to be governed of one another; and to produce disease, is to govern and be governed, one part by another, contrary to nature."—PLATO.

"The Athenians had become the parasites of their slaves, but it was still more ominous that they had become the parasites of their allies."

"Like Athens, Rome had become the parasite of her subject peoples."—W. R. PATERSON.

§ 1. The Psychical Life according to the *Evolution of Sex*.
§ 2. The Case of the Cuckoo.
§ 3. The Constitutional Basis of Criminal Habits.
§ 4. Disharmony proportioned to Degree of Parasitism.

§ 1. *The Psychical Life according to the "Evolution of Sex"*

"HITHERTO we have been justifying the orthodoxy of an anatomical training, by almost wholly ignoring the fact that animals have a psychic life, or only mentioning the mere neural aspect of functions. Only in discussing sexual selection, and the general facts of sexual union and of parentage, have we intruded words like 'care,' 'sacrifice,' and 'love.' A purely physiological treatment of sex and reproduction is, however, obviously incomplete. It would be rejected with scorn in reference to human life; it must be equally rejected in regard to the higher animals, which, taken together, exhibit the analogues of almost every human emotion, and of all our less recondite intellectual processes. It is with emotions that we have here most to do; and without raising the difficult question whether animals exhibit any emotions exactly analogous to those which in man are associated with the 'moral sense,' 'religion,' and 'the sublime,' we accept the conclusion of Darwin, followed by Romanes and others, that all other emotions which we ourselves experience, are likewise recognisable in less perfect, or sometimes more perfect, expression in the higher animals. Those which are associated with sex and reproduction are indeed among the most patent; love of mates, love of offspring, lust, jealousy, family affection, social sympathies, are undeniable."

After passing under review the various stages of psychical development in the evolutionary ladder, the authors go on to state that: "The fact to be insisted upon is this, that the vague sexual attraction of the lowest organisms has been evolved into a definite reproductive impulse, into a desire often predominating over even that of self-preservation; that this again, enhanced by more and more subtle psychical additions, passes by a gentle gradient into the love of the highest animals, and of the average human individual.

"But the possibilities of evolution are not ended, and though some may shrink from that comparison of human love with its analogues in the organic series, the theory of evolution offers the precise compensation such natures require. Without recognising the possibilities of individual and of racial evolution, we are shut up to the conventional view that the poet and his heroine alike are exceptional creations, hopelessly beyond the everyday average of the race. Whereas, admitting the theory of evolution, we are not only entitled to the hope, but logically compelled to the assurance, that these rare fruits of an apparently more than earthly paradise of love, which only the forerunners of the race have been privileged to gather, or it may be to see from distant heights, are yet the realities of a daily life towards which we and ours may journey."

What Geddes and Thomson here as elsewhere, however, fail to show, is, how rise of type was attended by increasing rectitude of physiological function, by an increasing teleological value of the respective lives, and how, on the other hand, absence of desirable psychological developments, as of parental care, goes hand in hand with presence of parasitism and antithetic development.

§ 2. *The Case of the Cuckoo*

Let us now turn to the curious case of the cuckoo, which we find stated at this stage in the *Evolution of Sex*. We must consider it at some length, for it illustrates into what *culs-de-sac* the old metabolic theory and its corollaries are leading.

"The cuckoo illustrates the evolution of a criminal habit, mainly due to constitutional conditions." Here, for the first time, we come across the significant phrase, "the evolution of a criminal habit." The "bias" is duly re-transferred from a "katabolic environment" to its proper place within the organism, although, of course, the nutritional origin of the diathesis is not clearly set forth.

"Without exposing the details of the crime list, it will be instructive, as a concrete illustration, to discuss at some length the parasitic instinct of the cuckoo. Every schoolboy knows that the female cuckoo shirks the brooding sacrifice usually associated with bird maternity. But though as the Scriptures say, somewhat too severely, of the ostrich, 'she is hardened against her young ones, as though they were not hers,' she is not 'deprived of wisdom'; by an elaborate and well-executed trick she foists her several eggs, at intervals of a few days, into the nests of various birds, which are usually insectivorous and suited for the upbringing of the intruder. The foster-parents, all unconscious of being fooled, hatch the cuckoo egg among their own. The nestling grows rapidly, and is a dog in the manger by birth. Greedy and jealous, he (the pronoun is oftenest correct) soon asserts his monopoly of nest and food and care, by the summary eviction of the rightful tenants, whether they be still passive *in ovo* or more awkwardly assertive as nestlings. The result is the success of the stronger. Of this habit there are various explanations, but the prevalent one regards it as only a special case of universal method which favours selfishness. Jenner was the first to emphasise what he regards as obvious advantages of the trick. The bird has but a short time to stay in its breeding area, and much to do in that short time. 'Nature,' he said, 'has a call upon it to produce a numerous progeny,' and as it is at the same time advantageous to migrate early, the gain of leaving the eggs to a succession of other birds to incubate is manifest. Darwin supposed the habit to crop up as a mere fortuitous variation, as it occasionally does in the normally nesting American cuckoo. The result was an advantage to the parent, and also to the offspring; the former got away sooner, the latter were better cared for. Those that learned the trick prospered, those that did not were eliminated; and so, in virtue of its natural or unnatural success, the device passed from being exceptional to become universal—became, in fact, an inherited specific instinct. Commenting upon this, Romanes, in a surely somewhat sanguine passage, says: 'We have here a sufficiently probable explanation of the *raison d'être* of this curious instinct; and whether it is the true reason, or the only reason, we are justified in setting down the instinct to the creating influence of natural selection.'"

The cuckoo, it is clear, is a pronounced criminal—*parasiticam cœnam quærit.* His constitutional developments are not along teleological lines. The female shirks the brooding sacrifice. Highly significant, again, as illustrating biological retribution in the field of teleological adjustment, it is, that insectivorous birds fall a prey to the cuckoo's trick—only one of innumerable instances of the fatalities teleologically arising which implicate the predatory types. The offspring inherit the parasitic and predatory trait—*lascivi soboles gregis.* The usual expansion of the predatory into criminal and brutal habits sets in very early. The nestling is "a dog in the manger" by birth.

The enormity of such aberration is fondly believed to be accounted for by postulating "a universal method which favours selfishness." But is the widespread occurrence of crime a legitimate reason for pleading its serviceableness?

Obviously, indeed, there is some "advantage" to such and similar tricks. But what of the reverse side? What of retribution? What of justice? This pleading of utility is exactly on a par with that imputed in Plato's *Republic* to Trasymachus, the upholder of injustice, to whom it appeared that in all cases "what is the advantage of the more powerful, the same is just" (such, at least, as are able to do injustice in perfection). It is the merest assumption, that "nature" has a special call on the cuckoo as regards fertility. Redundant multiplication we have found to be part and parcel of the nemesis of parasitism. The whole case represents a calamitous disease blatantly associated with crime—be this consciously or unconsciously. It is almost incomprehensible how a man of Darwin's type could adduce a plea of utility in so obvious a case of crime.

§ 3. *Constitutional Basis of Criminal Habits*

Geddes and Thomson, however, very commendably would rather dismiss the view of the utilitarian basis emphasising the advantages to the young cuckoo. And in order to support their own views, they provide a most remarkable enumeration of parasitic degeneracy and vicissitudes, a chapter of backsliding as instructive as a tale of natural history could well be.

According to their metabolic position, we are to set down the cuckoo's abnormality to a "deliberate expression of the whole constitution of the bird."

(1) The general character of the cuckoo is very significant. Brehm describes it as a "discontented, ill-conditioned, passionate, in short decidedly unamiable bird." "The note itself, and the manner in which it is emitted, are typical of the bird's habits and character. The same abruptness, insatiability, eagerness, the same rage, are noticeable in its whole conduct." The cuckoos are notoriously unsociable, even in migration individualistic. They jealously guard their territorial "preserves," and verify in many ways the old myth that they are sparrow-hawks in disguise. *The parasitic habit is consonant with their general character.*

(2) *The species consists predominantly of males.* The preponderance is probably about five to one,

though one observer makes it five times greater. In so male a species, it is not surprising to find degenerate maternal instincts.

(3) Reproduction and nutrition, we have seen, vary inversely. The love-impulses wane before those of hunger. Now, there is no doubt that even among greedy birds the cuckoos hold a very high rank. *They are remarkably insatiable, hungry, gluttonous.* Even the anatomical conditions asserted by some to be important, *the swollen, low-set stomach*, may have their influence in the cuckoo, which has certain other peculiarities, though the same conditions may be overcome in other birds which remain perfectly natural. It might almost be suggested that the habit of feeding so largely as cuckoos do on hairy caterpillars, whose indigestible hairs form a fretwork in the gizzard, may also have its irritant, gizzard-fretting, dyspeptic influence. But the main point is that, in a bird with so strong nutritive impulses, it is little wonder the reproductive emotions are degenerate. There is too much hunger and gluttony for the higher development of love.

(4) The reproductive relations of the sexes are at a lower level than polygamy, or rather polyandry. The males and females do not pair in the strict sense; there is no keeping company, though the males are said to be passionate during the breeding season. Nor is the female in its adult state externally distinguishable from the male.

(5) The reproductive organs of both sexes are very

small for the size of the bird. There is said to be a diminished blood-supply. Little wonder then that the reproductive emotions are in degree slightly developed. The sluggish parturition, at intervals of six to eight days, is also striking and significant.

(6) The eggs are remarkably small. While the adult cuckoo is some four times the size of the adult skylark, the eggs are about the same size. The American cuckoo, which is only occasionally parasitic, lays full-sized eggs. It is true that the size of an egg is not always proportioned to the size of the bird ; but it is reasonable to believe that when a bird, for constitutional conditions, seems to require all it can for itself, then it will have less to spare for its reproductive sacrifice. To say that the small size of the cuckoo's egg is "an adaptation in order to deceive the small birds" seems to strain the natural selection theory to the breaking-point.

(7) It has been usual in discussing beginnings to take some cue from the young stages. It is noteworthy, in this light, to emphasise the *jealous cruelty* of the young form—a fit prophecy of the adult character. In the restlessness of rapid growth, the nestling expresses the constitution of the species in selfish monopolising greed and insatiable appetite. Observations are recorded of the persistence of the cruel disposition into adolescence, though it usually wanes with the anatomical peculiarity of the back, not very long after birth. The young form at any rate exhibits the essential character of the species.

(8) Some corroboration is obtained from the character of the American cuckoo. There seems no doubt that it is occasionally parasitic, and it is interesting to note that observers speak of its *unnaturally careless indifference for the fate of its young.* The character, in fact, is less markedly evil; the occasional parasitism is just as intelligible as the occasional "reversion" of our cuckoo to ancestral habits, even in some cases to apparent affection for the young.

(9) In the cow-birds, again, where the habit occurs in different species in different degrees of perfection (if the term be admissible), the character is strikingly immoral. In one species (*Molothrus cadius*) a nest may be simply stolen, or the rightful nestlings may be thrown out, or actual parasitism may occur as an exception. In *Molothrus canariensis,* the eggs may be dropped on the bare ground, or fifteen to twenty from different parents may be lazily and of course fatally huddled together in one nest. Two cuckoo eggs are sometimes found in one nest. In *M. pecoris*, which is polygamous, the crime has been evolved, and the habit is that of our cuckoo, one egg being laid in each foster nest. "The important point is the general immorality and reproductive carelessness, which in one species finds expression in an organised device."

Brehm's description is highly significant. It introduces a most important psychological factor, generally quite disregarded, namely, that regarding the happiness or otherwise of the organism under parasitism. We catch a glimpse of the anarchy and horrors of the inner life conditions—of the *misère psychologique*—in such modes generally. If the statement that "the parasitic habit is consonant with their general character" deserves emphasis, it is antecedently true that it is the parasitic habit which has gradually produced discrepancies of constitution, and *pari passu* further deteriorations of general character.

Darwin himself could not but sometimes recognise the association between the predatory life and misery of inner psychological states. Thus, in the *Descent of Man* we find him remarking: "As Sir J. Lubbock has well observed, it is not too much to say that the horrible dread of unknown evil hangs like a thick cloud over savage life, and embitters every pleasure."

In paragraph 2 we encounter a remarkable case of sexual antithesis consonant with the prevailing state of parasitism. Again it is putting the cart before the horse, and a misconception of the universal factor underlying such antitheses, to say that, "in so male a species, it is not surprising to find degenerate maternal instincts."

I have shown that the universal tendency of parasitism is towards unstable equilibria, that it is opposed to normal lines and normal numbers, to symmetry of size and shape alike as to symmetry in segmentation and reproduction generally. I have also indicated that the degree to which teleological duties are discharged by a species determines survival value. These specific duties the cuckoo as a class shirks, and its predatory habits eventually expand into general lasciviousness, sexual callousness, selfish monopolising greed, and general criminality. It becomes a highly unclean animal, its impure life involving dangers to itself as much as to others. The sexual antithesis is only proportionate to the teleological disharmony that the case presents.

The alleged "maleness" of the species must thus be regarded as but a peculiar mode of parasitic visitation. It has only this connection with the "degeneration of maternal instinct," that male and female alike are involved in flagrant transgression. The female, under the obtaining parasitic diathesis shirking her duties of reproductive sacrifice, becomes the greater offender and succumbs first. The specific femaleness atrophies under a general pathology. The goal of extinction is approached, though sexual dissolution take place in the reverse order from that more commonly obtaining.

In the third paragraph it is set forth in unmistakable language that *as a class* the cuckoo is one of the most greedy of birds — "remarkably insatiable, hungry, gluttonous." No reference, however, is made to the origin of the diathesis thus implied. Evidently we are supposed to accept it all as "natural." The morphological inclination in parasitism towards amorphism—"the swollen, low-set stomach"—is most appropriately mentioned, as is also the predominance of nutrition and its possible "dyspeptic" influence.

What are we to think of the manifold deteriorations of disposition and of the innumerable inner vicissitudes caused by the perpetual dyspepsia involved in parasitism generally?

The metabolic thesis of Geddes and Thomson as a transitional one undoubtedly had its value, and was bound to prepare the way for more appropriate conceptions regarding the rôle of metabolism in nature. It is false, however, to put the cart of a diminished blood-supply, frequent in parasitic cases, before the horse of the antecedent cause—cessation of teleological function.

§ 4. *Disharmony proportionate to Degree of Parasitism*

The reproductive and domestic disharmonies in the case of the cuckoo plainly vary with the different degrees of parasitism exhibited by the bird in the various countries. It is only too true that an organism requiring all it can get for itself "will have less to spare for its reproductive sacrifice."

Constitutional conditions, race-propagation, and race-maintenance under such predicaments are insensibly but irrevocably shifting their centre of gravity until the whole edifice becomes highly unstable and dangerous. Is it not at least very striking that the American cuckoo, said to be "only occasionally parasitic" (meaning parasitic to a lesser degree) not only is reported to lay "full-sized eggs," but also to be of a character "less markedly evil." Geddes and Thomson, however, stop short at the conclusion that "the cuckoo's habit is a natural outcrop of the general character of constitution."[1]

---

[1] It is singular that in a revised edition of the *Evolution of Sex* the case of the cuckoo has been entirely dropped. Is it because its profounder consideration strains the metabolic theory contained in that book to breaking-point?

SUMMARY

The cuckoo is an instance of the evolution of a criminal habit originating in nutritional trangressions. The plea of utility in the cuckoo's trick is preposterous and sophistical.

The case shows:—

1. Extreme illegitimacy in the physiological basis of life — infeeding, insatiability, gluttony, and parasitic dyspepsia.
2. Marked sexual and domestic antithesis — polyandry, callousness. There is nothing to spare for reproductive sacrifice.
3. Pronounced *misère psychologique*, a passionate, ill-conditioned character.
4. Anatomical disfigurement and disproportion.
5. General immorality. Criminal behaviour towards others —a "markedly evil" character.
6. A selfish, monopolising greed. Pronounced jealousy of "preserves" and unsociability.
7. Hereditary transmission of criminal propensities.

All this coincides with the conclusions I have been throughout trying to establish as to the inevitable nemesis resulting from the parasitic habit wherever developed.

CHAPTER X

LAWS OF MULTIPLICATION

"The population question is the real riddle of the sphinx, to which no political Œdipus has as yet found the answer. In view of the ravages of the terrible monster, over-population, all other riddles sink into insignificance."—HUXLEY.

"History has her own chapter of pathology."

"The process of organic decay appears to be as irresistible in those great organisms called nations as in the most minute forms of life."

"States perish by various forms of that 'excess' which, as some Greek thinkers showed, is fatal to prosperous action."—W. R. PATERSON.

"Ex vitio alterius sapiens emendat suum."

§ 1. Metabolic Antitheses foreshadow those of Population.
§ 2. Herbert Spencer's "Inverse Ratio."
§ 3. Population and "Struggle."
§ 4. Spencer's Ratio and the Time Element.

§ 1. *Metabolic Antitheses foreshadow those of Population*

WITH the conclusions so far reached regarding the significance of nutrition in survival and reproduction, we may now venture to proceed to the further disentanglement of difficulties presented by the problems of population.

Throughout we found it confirmed that the occurrence of antithetic developments is due to dysteleological function, *i.e.* physiological transgression. I could easily multiply instances proving that beauty, stability, and equity of economic and social conditions can subsist only when solidly based on the rock of physiological rectitude. Equally so, ratios of multiplication in population are primarily determined by physiological habit, as will presently appear.

We are told in the *Evolution of Sex*: "The rate of reproduction depends upon the constitution of the individual and its immediate environment, including, above all, *its nutrition*. The rate of increase or decrease depends upon the wide and complex conditions of the entire animate and inanimate environment, or upon the degree of success in the struggle for existence. That there are enormous differences in the rates of reproduction is very evident. Maupas tells us how a single infusorian becomes in a week the ancestor of a progeny only computable in millions—of numbers which the progeny of a pair of elephants, supposing they all lived their natural terms of years, would not attain to in five centuries. Again, Huxley calculates that the progeny of a single parthenogenetic plant-louse—supposed again to live a charmed life—would in a few months literally outweigh the population of China. The geometrical rates of reproduction so often emphasised, would indeed have startling results if it involved real, and not merely potential, increase. That it does sometimes realise itself for short periods or special areas of favourable conditions is well known; for instance, in the periodic plagues of insects, or in the still unmastered rabbit pest of Australia. But in the established fauna and flora of a country, without intruded importations or marked climatic changes, *the rise and fall of population is seldom emphatic.* The rate of reproduction is only one factor in the numerical strength of the species or in its increase. The common tape-worm produces myriads of embryos, but these have only one chance in eighty-five millions (it is said) of succeeding. Many common and numerous animals reproduce very slowly. That some species are on the increase, *e.g.* bacteria, under the unprecedentedly favourable conditions which our recent 'industrial progress' affords, while other species are on the decrease, *e.g.* many birds, is certain; but the rate of reproduction is not a direct condition in either case."

In general terms, the factor of nutrition is thus recognised as a *punctum saliens* in reproduction, but in the place of a due elucidation of its importance, the ground is shifted to the vague proposition of the "struggle for existence." The "enormous differences in the rates of reproduction" alluded to are a matter of physiology and of pathology, and can never be adequately accounted for in the ordinary terms of the "struggle for existence." That the changes of ratio are seen to be "seldom emphatic," has its foundation in the fact of teleological adjustment such as I am here for the first time attempting to set forth.

The geometrical ratio of multiplication obtaining in aberrant types and in hypothetical cases is thus generally introduced without having previously received its true setting. I have already traced the connection between startling increase and parasitism, and it was concluded that exorbitant fecundity, like many another startling phenomenon of reproduction, is a symptom of pathological development attended by loss of survival-capacity.

§ 2. *Herbert Spencer's "Inverse Ratio"*

Spencer's familiar generalisation regarding population is to the effect that "individuation and genesis vary inversely." Summarising it, Geddes and Thomson supply the following data: "Different species exhibit different degrees of fertility, which have become established in process of evolution like the organisms themselves. To understand this particular adaptation of function to conditions of existence, of organism to environment, we may analyse these into their respective factors. It is evident that in the environment of any species there are many conditions with which its individuals establish a moving equilibrium, sooner or later overthrown in death. To prevent extinction, the organism meets these environing actions in two different ways—(1) by individual adaptations, active thrusts or passive parries; (2) by the production of new individuals to replace the overthrown, in other words, by genesis. The latter may occur, as we have seen, in varied forms, sexual or asexual, and at various rates, which depend upon age, frequency, fertility, and duration of reproduction, together with amount and nature of parental aid. These actions and reactions of environment and organism admit of another grouping in more familiar terms, into two conflicting sets—(*a*) the forces destructive of race, (*b*) the forces preservative of race.

"Leaving aside cases in which permanent predominance of destructive forces causes extinction, and also, as infinitely improbable, cases of perfectly stationary numbers, the inquiry is: In races that continue to exist, what laws of numerical variation result from these variable conflicting forces that are respectively destructive or preservative of race? How is the alternate excess of one or other rectified? A self-sustaining balance must exist; the alternate predominance of each force must initiate a compensating excess of the other: how is this to be explained? When favourable circumstances cause any species to become unusually numerous, an immediate increase of destructive influences, passive as well as active, takes place; competition becomes keener and enemies more abundant, and conversely. Yet this is not the sole, much less the permanent, means of establishing a balance; nor does it explain either the differences in the rate of fertility and mortality, or the adaptation of one to the other. This minor adjustment in fact implies a major one. The forces preservative of race were seen above to be two—power to maintain individual life, and power to generate the species. Now, in a species which survives, given the forces destructive of race as a constant quantity, those preservative of race must be a constant quantity also; and, since the latter are two, the individual plus the reproductive, these must vary inversely, one must decrease as the other increases. To this law every species must conform, or cease to exist. Let us re-state this at greater length. A species in which self-preservative life is low, and in which the individuals are accordingly rapidly overthrown in the struggle with the destructive forces, must become extinct unless the other race-preservative factor be proportionately strengthened—unless, that is to say, its reproductive power become proportionately great. On the other hand, if both preservative factors be increased, if a species of high self-preservative power were also endowed with powers of multiplication beyond what is needful, such success of fertility, if extreme, would cause sudden extinction of the species by starvation, and if less extreme, and so effecting a permanent increase of the members of the species, would next bring about such intenser competition, such increased dangers to individual life, that the great self-preservative power would not be more than sufficient to cope with them."

We have here at least an adumbration of the view that degrees of fertility are teleologically determined much the same as the status of a species itself. The way in which such adaptation is here said to have arisen, however, must remain somewhat conjectural, in view of the fact that actions and reactions of environment and organism have not previously been duly accounted for, and that neither the forces destructive nor those preservative of race have been adequately considered. Little wonder, then, that the subsequent reasoning is attended by frequent flaws.

By what logical sequence can it be declared that "favourable circumstances" must necessarily produce an immediate increase of destructive influences—unless we qualify "favourable circumstances" to mean the general causes of *un*favourable physiological development? That enemies *must* of themselves grow more abundant in proportion as a species increases, is a pure assumption, however frequently, under existing conditions, such a state of things may prevail. There is indeed the saying, "*Totidem hostes esse quot servos*," but it plainly refers to the inevitable nemesis visiting those that indulge in parasitic nurture and in slave-making, and generally set up the causes of pathological development in the universe. We must not mix up genuine factors of growth with pathological ones.

It is quite legitimate to ask why a race, having produced a fair moving equilibrium, should not with greater numerical strength find it all the easier to keep intending enemies at bay? Indeed, we found this to be the ordinary occurrence in nature. It is now generally conceded by historians that Babylon, Athens, and Rome did not perish from an excess of outer enemies, but rather from an inner rottenness. Have we not seen that gregarious animals are more formidable to enemies than solitary types? Again, why should not normally a family of twenty, if united, be stronger and prevail against one of five or eight?

Either the term "favourable circumstances" is read with the proviso, "which conditions, however, in reality are unfavourable when the life of the species is regarded," or the position that an increase in numbers in itself produces an abundance of enemies must be given up. It is a *non-sequitur*.

§ 3. *Population and "Struggle"*

Again, the more we learn about the important factor of affinities existing between organisms, the more does it become patent that enemy-making is a matter of dysteleological habits and functions, as has already been pointed out in Part I.

Such habits produce an increase which is not genuine, but rather pathological, and therefore pregnant with retributions. The species is now its own greatest enemy and destroyer. It is courting the furies of exhaustive competition and of dissolution; it has itself invoked Mars and nemesis. The social instincts, like those of the cuckoo, now tend in the direction of chaos. Biological isolation is at the same time intensifying. What fraction of nutritive environment remains available to a type growing more and more fastidious, becomes a matter of cruel competition and exclusive "preserves." "*Omne nimium vertitur in vitium.*" Antithetic development is thus materialising—first begun by a straying from the normal metabolic path. We have seen that the real forces destructive of race, and their symptoms, are not even roughly apprehended, and that it is an absurdity to postulate "a species in which self-preservative life is low," but which maintains itself by a proportionate increase of "reproductive power." So far from such a contradictory augmentation of power really occurring, exhaustion and nemesis are indicated, and a mere dissociative device is exercised, barely and woefully to maintain some kind of a *status quo.* Genuine power is rapidly waning.

The various allusions to an increase of destructive influences when "favourable circumstances" cause species to become "unusually" numerous thus really apply to pathological states.

"Struggle" is primarily conditioned by constitutional developments. We have seen that there exist powerful (teleological) needs of stability. Whatever parts of an organism or a race—notwithstanding an otherwise high relative status—seriously imperil this stability require elimination. This is what is really at the bottom of Sir E. Ray Lankester's statement that "the survival of the fittest alludes exclusively to the struggle within the borders of a race."

§ 4. *Spencer's Ratio and the Time Element*

Geddes and Thomson seem to have felt the sense of unreality which must come to every unbiassed reader of Spencer's inferences :—

"It is indeed evident *a priori* that, if the cost of individuation be once provided for, a higher nutrition will render possible a greater propagation, sexual or asexual, and this may be abundantly verified by observation and experiment. Witness the case of aphides, in which the rate of parthenogenetic reproduction is found to be directly proportioned to temperature and food-supply ; or, again, that of domestic animals, such as the sheep, whose fertility is in direct relation to richness of pasture and warmth of climate ; or, finally, and most obviously of all, that of field or fruit crops, upon which the influence of increased liberality of manuring will not be disputed. Yet it is sometimes maintained, for both plants and animals, that over-feeding checks increase, while limited nutriment stimulates it ; and to support this view there are cited such cases as that of the barrenness of a very luxuriant plant, and the fruitfulness which appears on its depletion. But if this objection really held, manuring would in all cases be inexpedient, instead of only in plants where the growth of sexless axes is still too luxuriant ; and a tree which has borne a heavy crop should, by this depletion, bear again yet more heavily, instead of being more or less barren next year unless manured. Or the difficulty may be met by interpreting such vegetative luxuriance, not as a case of higher individuation at all, but simply as a case of asexual multiplication of secondary axes ; or again, and perhaps most simply, by regarding the appearance of sexual reproduction on repletion simply as a case of the previously demonstrated antagonism between genesis and growth.

" But again, since fatness is associated with sterility, it is often argued that high feeding is unfavourable to genesis. Obesity, however, is now known to be associated with imperfect assimilation, with physiological impoverishment or degeneration—by no means with that constitutional wealth which is favourable to fertility. If, in short, we bear in mind that truly high nutrition means only due abundance of, and due proportion among, all the substances which the organism requires, and that their perfect assimilation by the organism is also needful, such objections to the generalisation not only disappear, but such a phenomenon as the coincidence of returning fertility with disappearing obesity affords a confirmatory argument."

Again we have the nutritive overflow and its dire effects upon sex very prominently laid before us.

Just as obesity is at last recognised as associated with imperfect assimilation, so in manuring we shall have to discriminate as to the conditions of assimilation. The promiscuous ways in which soil and plant alike have in the past been treated are frequently not conducive to a perfect nutrition. The contrary is the case, and generally degeneration is caused by superfluous and impure manuring, which causes a dyspeptic condition of the soil. Again we would retort to Geddes and Thomson's argument: "*Ex abusu non arguitur ad usum.*" Manuring need not in all cases be inexpedient. But where have they adduced any guiding principles by which to improve on the extreme crudity and primitiveness of prevailing methods? With their notions regarding parasitism, constitutional bias, antithetic development, metabolic ratios, etc., how will they propose to accomplish "perfect assimilation" and the correlated desideratum of "due proportion among all the substances which the organism requires"? The importance of the fertilising influence of sunlight is now increasingly coming to the front. It is thus pointed out in *Nature*, No. 2103. vol. lxxxii. p. 456, that except in market-garden crops near the cities, and in crops like sugar-cane and tobacco, manures are but little used in India. The growth of leguminous crops and the weathering of the soil during the hot season appear to be sufficient to keep up the fertility. Reference is also made to the statement by Drs Russell and Hutchinson that: "There is reason to suppose, therefore, that the large destructive and competing organisms will be found of common occurrence in ordinary soils, checking the beneficial bacteria and limiting fertility. An important practical problem arises: is it possible to suppress them in the ordinary field soils by any economical and practical process?" The writers in *Nature* state that: "The practice among many of the best cultivators in the Indo-Gangetic plain furnishes a most emphatic affirmative to the above question. It has been the practice of the ryots for centuries past to expose the alluvial soils of the plains of India to the intense heat and light of the Indian hot weather in April and May. The beneficial result on the succeeding crop is extraordinary, and has all the effect of a nitrogenous manuring."

A few very important considerations emerge from these facts. First of all, it is patent that the immense teleological significance of the primordial and perennial influx of solar energies cannot be left unallowed for in considerations bearing on the ratio of sustenance and population.

The matter of "weathering" the soil at the same time is pregnant with considerations of a teleological order. It implies steady—non-accelerated—occupation on the part of the cultivator, producing desirable physiological and sociological effects upon the population thus employed, and incidentally it furthers the interest of those plants the seed-production of which is characterised by a teleological margin. The case of the endosperm of Indian corn and of the sarcocarp of the apple, as typical instances illuminating the teleological point of view, have already been referred to. We also see that, regarded as a whole, the more teleological function increases on our globe, the more frequently must dysteleologically (predaceously) functioning types of organisms find themselves faced by strong and resisting (teleological) organisations, to which frequently they have to give way.

On the point of manuring Sampson Morgan, in the paper already alluded to, further points out: "Fruits are what their food makes them. . . . It is open to question if modern fruit-growers know how to feed scientifically for fruit at all. Too often they get the soil and trees into a dyspeptic condition, but the fruit from dyspeptic trees and soil cannot form the perfect food for man."

"An excess of nitrogen, especially in the form of nitrate of soda or of sulphate of ammonia, produces injurious effects in the fruit field. . . . The use of manure is almost equally bad, and as to sewage, chemically treated or otherwise, its utilisation for the production of fruits or plants for food should be prohibited by law. As far as manure is concerned, the notion prevails among numerous agriculturists that its effectiveness is proportionate to its unsavouriness."

"Strong-smelling composts should never be permitted to enter the fruit-farm or flower-garden of the patron of hygiene. If I am asked whether these composts are not essential, I reply they are not. Nay, more, I hope to show that far larger yields and finer fruits and flowers can be produced without them. Naturally, what I commend for fruits are equally suitable for grains and general market-garden products. Under the improved system of culture, manure or artificial fertilisers are unnecessary. I am not in sympathy with the chemists who are ever singing the praises of man-fed nitrogen."

"Vegetables fed with sewage, when cooking give off a pronounced unsavoury odour. Rose-bushes fed with sewage or dosed with manure, particularly such as is saturated with ammonia from the stable, develop *weak, watery growth, which readily falls a prey to sucking plant pests and degeneration of tissue.* It is sacrilege to feed the queen of flowers with sewage or manure. Anything which produces ammoniacal decomposition should be avoided by cultivators. Blindness in strawberry plants, and many other affections, often result from the use of such materials. The hard-grained wheats which the importers prize above those produced by the home farmer owe their firmness to a sweet and naturally fertilised soil. The grains from the manure-fed fields of the United Kingdom owe their softness of texture to the food furnished to the plants which bore them. Stable manure is responsible for the creation and perpetuation of many ailments. It affects the food-stuffs used for feeding cattle and men. I am satisfied that most of the dental troubles which afflict the community could be traced to the continued use of soft-textured manure and fertiliser-fed wheat." . . .

"The excessive use of nitrogenous material in the form of manure in potato-culture is productive of weak growth or haulm—which lowers the constitution of the plants and tubers so that they readily succumb to the dreaded disease." "In the past, millions of money have been lost through the potato disease. With the use of new seeds, and the planting of same in a well-drained soil enriched with natural manure, not only are disease and scab preventible, but the yield can be increased threefold, and the monetary value of the tubers harvested be enhanced considerably at the same time. Can anyone imagine that the flesh of potatoes which suffer from the slightest taint of disease or from scab of skin, a kind of eczema, really is as good for consumption as the flesh of tubers consisting of healthy tissues?"

But to return now to the *Evolution of Sex*, and to ratios of population: "Organisms having aberrant modes of life are next appealed to for crucial evidence bearing on these general doctrines. Thus, turning to vegetable and animal parasites, which combine superabundant nutrition with greatly diminished expenditure, the enormous fertility exhibited by all such forms is seen to be the necessary correlative of such a state of nutrition and expenditure, and not merely an acquired adaptation to their peculiar difficulties of survival. The reversion exhibited by so many species (especially among the higher arthropods, *e.g.* Aphis, Cecidomyia) from sexual reproduction to primitive forms of genesis, is explained by pointing out that such species are peculiarly situated in obtaining abundant food with little exertion. Among bees, ants, and termites alike, the enormous fertility of the inactive and highly nourished queen-mother are obviously also cases in point."

Remembering that hitherto in biological literature those aberrant organisms have been made to play so prominent a part, it is curious to find that the serious problem of their frequently exorbitant rate of fertility is to be settled in such discursive fashion, without clearly drawing and stating the inference required by Spencer's ratio as to their state of retrogression—their "degeneration *sui generis*." It is only too true, as I have been urging throughout, that such enormous fertility is not merely an acquired adaptation to their peculiar difficulties of survival, but is the necessary correlative of their nutritional state. But, if nutrition is the cause of redundancy, then it is a case for the physiologist or pathologist, and not for the "natural selectionist," to state the significance and value of such productions in exact terms of their respective sciences. The verdict, from the point of view of the most up-to-date physiological science, I have already unmistakably given in my previous statements that parasitism constitutes a case of degeneration *sui generis*, and that it is abhorred by nature.

As regards the Spencerian generalisation that individuation and genesis vary inversely, it is now patent that what inverse ratio there may normally exist between individuation and genesis, has in each case to be established by first divesting the existing growth of its pathological components. The principle then would probably require new formulation.

There exists, however, a reserving clause to Spencer's proposition, the need of which is frequently overlooked when the principle is applied.

"If time be left out of account as hitherto—or, what is the same thing, if all the species be viewed as permanent—the inverse ratio between individuation and genesis holds absolutely. But each advance in individual evolution (it matters not whether in bulk, in structure, or in activities) implies an economy; the advantage must exceed the cost, else it would not be perpetuated.[1] The animal thus becomes physiologically richer; it has an augmentation of total wealth to share between its individuation and its genesis. And thus, though the increment of individuation tends to produce a corresponding decrement of genesis, this latter will be somewhat less than accurately proportionate. The product of the two factors is greater than before; the forces preservative of race become greater than the forces destructive of race, and the species spreads. In short, genesis decreases as individuation increases, yet not quite so fast."

---

[1] This, of course, must stand the test of time.

But considerations of the time element cannot be left out, any more than plasticity and factors of dissociation, so fatally disregarded by Geddes and Thomson. Spencer's principle is thus seen to require a great deal of qualification, and his general ideas concerning the biological significance of developments require considerable correction in the light of recent thought.

When it comes to stability, frequently the time element constitutes an important criterion. Darwin's and Mendel's experiments with plants leave no doubt on the subject.[1]

An occasional crossing among certain types not infrequently alters the whole situation, interfering like a *deus ex machinâ* with the previous ratio. The crossing is generally tantamount to a rejuvenation of race, which a diminished surfeit has rendered possible, but which was also necessitated by reproductive requirements, unless, indeed, a lower range of propagation —*vide* confirmed parthenogenesis if not infertility— was to be courted.

The important conclusion that "nature abhors perpetual self-fertilisation" was derived by adequately allowing for the time element. In a deeper sense this word of Darwin's asserts, as we have seen, that a mode of life which yields a geometrical increase of population ("preserves" at the same time augmenting only arithmetically) is not conformable to nature. In the long run, and in respect of teleological value, this mode must include components detrimental to the maintenance of the equilibrium, thus necessitating deadly competition and costly reproductive nemesis (elimination).

---

[1] The impure and pure "dominants" of Mendelism cannot even be distinguished in appearance; only the test of breeding can do it.

To attach great importance to pressure of population as an incentive to progress, as Herbert Spencer has done in general terms, is justifiable enough. But it is necessary to remember that there are different kinds of "struggle," and that hence pressure *per se* may not be the desideratum. Necessity has, of course, been a great taskmaster in evolution, but the various necessities to which we find organisms committed frequently do not express normalities, let alone nature's possibilities.

When we are told that "the acute pressure of population, with its attendant evils, thus tends to cease as a more and more highly individuated race busies itself with its increasingly complex yet normal and pleasurable activities, its rate of reproduction meanwhile descending towards that minimum required to make good its inevitable losses," we are, indeed, referred to what is possible and desirable, but we know only too well from history that in effect great calamities are the general concomitants of a diminishing population. A falling rate which is marked by an increasing jealousy of "preserves," as instanced by the case of the cuckoo, by an increase of the tyrannical and criminal disposition, is not an indication of progress, but of the presence of retributive adjustment following in the wake of dysteleological functions, *i.e.* physiological transgressions.

SUMMARY

The fact that the rate of reproduction is not a direct condition of increase or decrease of population, rests on the fact of teleological adjustment. The enormous differences in the rates of reproduction are a matter of physiology and of pathology, and cannot be adequately accounted for in terms of "Natural Selection."

Spencer's contention that "individuation and genesis vary inversely" is supported by inadequate evidence, and, hence, frequently lends itself to misconstructions. An increase of mumbers does not necessarily produce a greater abundance of enemies; nor is a decrease of population generally attended by an improvement in individuation. An increase that is not genuine, is pregnant with retributive adjustment. "Struggle" is primarily conditioned by constitutional developments requiring adjustment according to inherent and teleological needs. It is a going beyond the necessaries of life on the part of individuals that spells the Darwinian "struggle."

The inference from Spencer's ratio, consistently applied, would be that parasitic multiplications must have their complement in a degeneration *sui generis*. The conclusion, however, is generally shirked, principally in view of the opposite ("selective") tenet that parasitism implies a genuine adaptation. Obesity is acknowledged as at last "known to be associated with imperfect assimilation, with physiological impoverishment or degeneration," and it is vaguely contrasted with an imaginary "constitutional wealth which is favourable to fertility," but no attempt is made to indicate where physiological wealth ceases and pathology sets in. The same strictures apply to current notions regarding manuring, which frequently produces a surfeited and dyspeptic condition of the soil. Recent researches regarding the fertilising influence of sunlight, as well as the experience of modern fruit-growers, strongly support the contention that animal sustenance is most effectively and legitimately obtained by conforming to a natural and teleological order of things.

The Spencerian ratio, as at present formulated, is apt to be misleading. It refers to possibilities, but cannot be applied to actual necessities without important qualifications becoming necessary. Pressure of population *per se* is no desideratum; nor is a falling rate by itself a criterion of development.

INDEX

Abnormal variations, 8, 69, 265, 355.
Algæ and male parthenogenesis, 246.
Allantois, 340.
Alternation of generation, 304 *et seq.*
American bison, 56.
Amœba, 354, 357.
Amœboid organisms, 235.
Amorphism, 18, 229, 382.
Amphimixis, 168–170.
Angiostomum, 188, 312.
Antithesis of numbers, 173, 263, 271, 324, 374, 386.
  of size, 18 *et seq.*, 53, 154, 238, 314, 324.
Ants, 125–126, 141, 227, 400.
Apes, 161.
Aphides, 255, 400.
Apus, 263.
Aquatic crustaceans, 261.
Archebiosis, 355.
Architectural aspects and diagnosis, 8, 218 *et seq.*
Armadillo, 121.
Artemia, 47, 262.
Arthritic tendency, 237, 317.
Arthropods, 217, 400.
Aryans, 35, 147.
Ascaris, 205, 221, 226, 347.
Asexual reproduction, 168, 241, 281 *et seq.*, 292, 394.
Atlantosaurus, 61.
Autonomy, 12, 40.
Axolotl, 336.

Balbiani, 200, 206.
Bastian, Ch., 355 *et seq.*
Bateson, W., 94.
Beard, Dr, 292.
Bees, 126, 227, 400.
Begonia, 52, 70.
Bergson, H., 1, 3, 168, 243, 281, 301.
Bernard, Claude, 169, 236.
Bivalves, 186.
Brachiopods, 190.
Brehm, 377, 380.

Carnivores, 16, 126, 129, 160–161, 318.
Casuarina indica, 92.
Cave fauna, 62, 101.
Cell-cycle, 232.
Chemical diathesis, 295, 354.
Chironomus, 51, 206–209, 210, 259, 348.
Chlorophyll, 17.
Cirripedes, 189.
Cities and agriculture, 144.
Claus, 189.
Cleistogamy, 22.
Clitomastus, 346.
Cœlenterates, 160, 296 *et seq.*
Colloid metals, 257.
Colonisation, 120–121.
Composite ova, 219.
Coniferæ, 24, 310.
Conjugation, 152, 168, 172, 361.
Constancy of average size, 317.
  of species, 165, 241.
Cope, 40, 319.
Corallium, 183, 300.
Cowslips, 23.
Cranes, 127.
Crepidula fornicata, 166.

Cross-feeding, 167, 170.
Crustaceans, 18, 186, 262.
Crystallisation, 8, 42, 283.
Ctenophores, 190, 300.
Cuckoo, case of, 373-384.
Cunningham, J. T., 44, 45.
Curtailment of existence, 21, 186, 188, 203, 208, 259, 308, 333, 345 *et seq.*

Dajus, 167.
Daphnia, 262.
Darwin, as influenced by Malthus, 4, 98.
  on earthworm, 12.
  on struggle for existence, 18, 29, 60.
  on insect fertilisation, 25.
  on inbreeding, 25, 172.
  on plant-feeding, 36.
  on "sports," 69-71.
  on natural selection, 87 *et seq.*, 110 *et seq.*
  on bilateral structure, 194.
  on case of cuckoo, 375, 377.
  on savage life, 381.
Degeneration, 194-195, 400-401.
Déperet, Ch., 46, 64, 165, 316, 318.
Dichogamy, 25, 185, 187.
Dimorphism (sexual), 18, 22, 382.
Dinosaurus, 317.
Direct action of environment, 122.
Disease, definition of, 13.
Dissociation, 8, 50, 164, 244 *et seq.*, 293, 295, 301, 311, 351, 355-357, 402.
Distomum, 306.
Dohrn, 193.
Domestication and exploitation, 23, 52-53, 87.
Drosera, 164.
Drummond, Henry, 5, 100, 159.

Early separation of sex-cells, 203 *et seq.*
Earthworm, 12, 182.
Echinoderms, 16, 221, 288.
Eigenmann, Prof. C. H., 62, 101.
Eimer, 152, 169.
Elimination, 13, 42, 43, 59, 172, 195, 220, 225.
Elodea canadensis, 266.
Embryonic cannibalism, 219, 258, 339.
  food-supply, 136, 216.
  hermaphroditism, 181.
Endosperm of Indian corn, 174-176, 397.
Environment defined, 10.
Ephemera, 52.

Female cannibalism, 160.
  preponderance, 195, 246.
Fern, 293, 308-311.
Fertilisation, 21 *et seq.*, 153, 168 *et seq.*, 220-222, 227, 236-241, 269, 272, 292, 320.
Fœtal membranes, 341.
Foraminifera, 354.
Fungi, 40, 268 *et seq.*

Galton, 241, 271.
Geddes and Thomson, 152, 169, 190, 193, 201, 215-216, 221, 225, 229, 238-241, 272, 277, 281, 313, 321, 323, 327-328, 337-338, 341-342, 360, 367-368, 373, 377, 383, 388, 393, 395, 402.
Gegenbaur, 191.
Germ-plasma, 335.
Goette, 346 *et seq.*
Gregarines, 353, 359.
Gregariousness, 161.
Groom, Prof., 310.
Gyrodactylus, 203, 336-337.

Haeckel, 311.
Hagfish, 189.
Hartog, M., 322.
Hatschek, 169, 222, 320.
Hensen, 168, 268.
Hermaphroditism, 25, 180 *et seq.*
Hertwig, 206, 224.
Huxley, 47, 72, 111, 270, 385-386.

Immortality (protozoon) 200 *et seq.*, 349 *et seq.*
Immunity, 13, 362.

Impregnation with inorganic matter, 11, 289 *et seq.*, 354.
Impurities and instability, 9, 249, 268, 291, 327, 354.
Indians, 144.
Infusoria, 355.
Insecta, 52, 216, 217, 219.
Insectivorous generations, 264 *et seq.*
Interdependence of organisms, 14, 16, 55, 274, 301.
Interior parasites, 162–164.
Intra-cellular energy, 8.
Isolation, 119, 190, 392.
Isomerisation, 9, 355.
Isophagy, 152, 263.
Isopoda, 167.

Katabolic emanations, 20.
preponderance, 233, 235, 266.
Kraepelin, K., 155, 163, 347.
Krause, 163.
Kropotkin, P., 5, 35, 97 *et seq.*, 137, 144.

Lancisi, 81.
Lankester, Sir E. Ray, 26, 31–33, 38, 41, 61, 167, 195, 198, 217, 331, 393.
Lapwings, 127.
"Law of battle," 21, 34, 36–37, 100, 108, 174, 217, 375, 393.
Le Bon, G., 244 *et seq.*, 303.
Lepidoptera, 30.
Lethrus cephalotes, 161.
Leucophrys patula, 165, 324.
Linaria vulgaris, 22.
Lindsay, Prof., 62, 143.
Liver-flukes, 306.
Lock, R. H., 29, 92, 174.

Macrocosmic tests of developments, 7, 12, 74, 99.
Magosphoera, 346.
Malthus, 4, 33, 64, 134 *et seq.*
Mammals, 17, 129, 215, 292.
Manuring, 395 *et seq.*
Marchantia, 287.
Martineau, Dr, 365.
Maupas, 165, 172, 324 *et seq.*, 361–2.
Mendelian ratios, 25, 269.
Mendelism, 43, 54, 402.
Menstruation, 337
Metabolic indolence, 20, 216, 260, 301, 318, 353, 400.
ratios, 19, 36, 236.
Metamorphosis, 19, 307–308.
Metchnikoff, 58.
Miastor, 258–259.
Mice, 141.
Minot, Dr, 224.
Moina, 208, 262.
Mollusca, 44, 220.
Morgan, S., 135, 397 *et seq.*
Moss, 308, 310–311.
Moulting, 283.

Natural checks to over-population, 140.
Nematodes, 208, 312.
Nemesis of reproduction, 294 *et seq.*, 311, 344 *et seq.*
"Nutrition and Evolution," summary of, 8–25.

Obesity, 395.
Œnothera lamarckiana, 70–76.
Onchidia, 16.
Onychodromus grandis, 173.
Orthonectids, 346–347.
Osmosis, 341.
Ovum, growth of, 213 *et seq.*

Pædogenesis, 17, 51, 182, 206, 210, 259, 276, 347 *et seq.*
Palæontology, 46, 51, 66, 76.
Parallel evolution, 91–92.
Paramœcium, 15.
Parasitism and disease, 13, 14, 39, 65, 187, 191, 235, 239, 260, 269, 327, 337, 362, 366, 376, 382, 400.
Parrots, 128.
Parthenogenesis, 19, 51, 173, 196, 225, 241, 243 *et seq.*, 312.
Paterson, W. R., 371, 385.
Pathogenic bacteria, 16, 43, 162.
Pearson, Prof., 237.
Philodinadæ, 262.
Phosphorescence, 9, 354.

Pigs and rabbits in New Zealand, 138.
Plant-organised food, 20.
Platner, 229.
Plato, 371, 376.
Plethora of nutrition, 190, 302.
Polar bodies, 222 *et seq.*
Polarity, 10, 12, 18, 256.
Pollen-production, 22–24.
Polygordius, 328, 346.
Polymorphism, 265, 298.
Polyphemus pediculus, 227.
Polyzoa, 347.
Poulton, Prof., 67 *et seq.*
Precocious reproductive maturity, 336 *et seq.*, 367.
Prepotency, 13, 24, 310.
Pressure of population, 403.
Primula obconica, 82.
Propagation,—teleological or otherwise, 50, 219.
Protozoa, 181, 199 *et seq.*, 233, 295, 350 *et seq.*
Pterodactyls, 61, 317.

Radio-activity, 9, 252.
Radiolaria, 354.
Réaumur, 256.
Rediæ, 308.
Regeneration, 283 *et seq.*
Reid, Archdall, on variations, 11.
Rhine-salmon, 229, 296.
Rolph, W. H., 152–154, 169, 236.
Ruptures and breakages, 294, 327, 346, 353–354.
Russell and Hutchinson, Drs, 396.

Sacrifice, 327 *et seq.*, 382, 383.
Sagitta, 208, 276.
Salt-water, 302.
Saprophytism, 17.
Sarcocarp of fruits, 135, 397.
Sastroblasta raffaelii, 299.
Self-adaptation, 77.
Self-fertilisation, 23, 185, 201, 225, 291.
Serranus, 188.
Sexual maturity, 333 *et seq.*
Siebold, von, 246, 259, 262.
Silk-moth, 248, 253.
Simon, 189–190, 275.
Sluggishness and feeding, 15, 189–190, 202, 204, 214, 300.
Smyth, N., 325, 338, 344–345, 364, 366.
Solidarity, 132.
Sousliks, 142.
Species, definition thereof, 9, 73.
Spencer, H., 5, 55, 169, 208, 209, 220, 321 *et seq.*, 388 *et seq.*
Spermatogenesis, 228, 236.
Spermatozoa, 225 *et seq.*
Sponges, 183, 296, 354.
"Sports," 8.
Starling, Prof. E. H., 38, 288, 303.
Starving males, 236 *et seq.*
Stonewort, 266.
Strasburger, 43, 75, 277.
Sunlight, fertilising effect, 396.
Susceptibility, 13, 63.
Syevertsoff, 109.
Symmetry of segmentation, 218.
Symptoms of parasitism, 13–14, 65, 160, 195.

Tadpoles, 166, 181.
Tapeworms, 189.
Teichmann, E., 169, 171.
Teleology—its use, 6, 49, 81.
Teleological margin of seed-production, 35, 135, 397.
  processes, 43, 55, 65, 67, 102, 157, 194–195, 204, 286, 310, 333, 376, 383, 393, 397.
Teratological developments, 47, 316 *et seq.*
Thiselton-Dyer, Sir W. T., 77, 81–82, 86.
Thomson, A. J., on germinal food-supply, 38, 209, 212.
  on variability, 47.
  on wild animals, 60.
Tiger, sabre-toothed, 121.
Transmission in parasitism, 21, 63, 219 *et seq.*, 225, 236, 376.
Trematodes, 188, 203, 306, 337.
True breeding, 9.
Trypanosomes, 62.
Tuberculous stocks, 237.
Tunicates, 189, 190, 221, 288, 303.

Under-population, 102.
Unicellular animals, 199 *et seq.*

Van Beneden, 221.
Variations, 8.
Vitality of sperms, 227 *et seq.*
Volvox, 203.
Vries, De, on the nature of protoplasm, 10.
  on mutations, 70, 78.
  on experiments, 72.
  on Lamarck, 81.

Wallace, A. R., on Darwinism, 26 *et seq.*, 111.
Ward, M., 327.
Weismann, on nature of protoplasm, 10.
  on variations, 11, 71.
Weismann on amphimixis, 168, 273.
  on protozoa, 199 *et seq.*, 351–357.
  on transmission of characters, 206, 209.
  on germ-plasm, 213, 335.
  on parthenogenesis, 223, 253, 277.
  on fertilisation, 239, 241, 271.
  on regeneration, 286.
  on death, 320, 367.
Whelk, 339–340.
Wilson, Prof. James, 53–54.
Woodward, A. S., 318.
Worms, 184, 216, 221.

Yolk-glands, 159, 216, 217, 262, 340
Yung, 166.

Zacharias, 226.

PRINTED BY NEILL AND CO., LTD., EDINBURGH.

LIBRARY

b

4724